Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

APRIL, 1953

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CHNOLOGY

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DETROIT

Modern Reversing Slabbing-Blooming Mills

Designed and Built by

MESTA

MACHINE COMPANY, ITTSBURGH, PA.

Color Photo by E. D. MESTA

MESTA 46" REVERSING SLABBING-BLOOMING MILL

FOUR FIT IN THIRTY INCHES

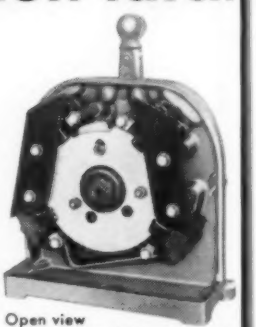
and Cutler-Hammer's NEW FLAT MASTER has grip release of off-position latch

In introducing Cutler-Hammer's New Flat Master, we don't have to tell an experienced steel man the advantage of being able to mount masters on 7½" centers. The New Flat Master is only 6 15/16" at greatest depth. This means these masters can be grouped in such a short span, the operator has any one in easy reach without stretching at all. It means he doesn't get so tired. It means his efficiency stays high.

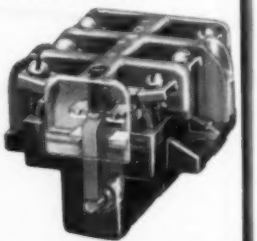
The advantages of the squeeze grip release of the off-position latch are equally compelling. Release results simply from tightening the normal grip. No extra motions. Less fatigue. And as easy and desirable as the squeeze grip release is in any position, it becomes a necessity when a master is mounted overhead.

These are but two of the many features making the Flat Master ideal for crane cab, open hearth charging machine and "all-vision" cab use. The Flat Master is designed throughout the better to meet steel mill needs. The rugged substantial cover lifts off straight up. The contact structure is simplified, all parts easily accessible, and easy to maintain. Movable and stationary contacts are readily replaceable, or the group assembly of 3 sets of contacts and operating rollers can be easily replaced as a unit. Twin break special alloy contacts, arc resistant molded supports, etc., provide long contact life and trouble-free service. There is ample wiring space. The sealed bearings are permanently lubricated. Many other features of fine, dependable performance recommend you get further information at once. CUTLER-HAMMER, Inc., 1269 W. St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER-HAMMER
MOTOR CONTROL
C-H



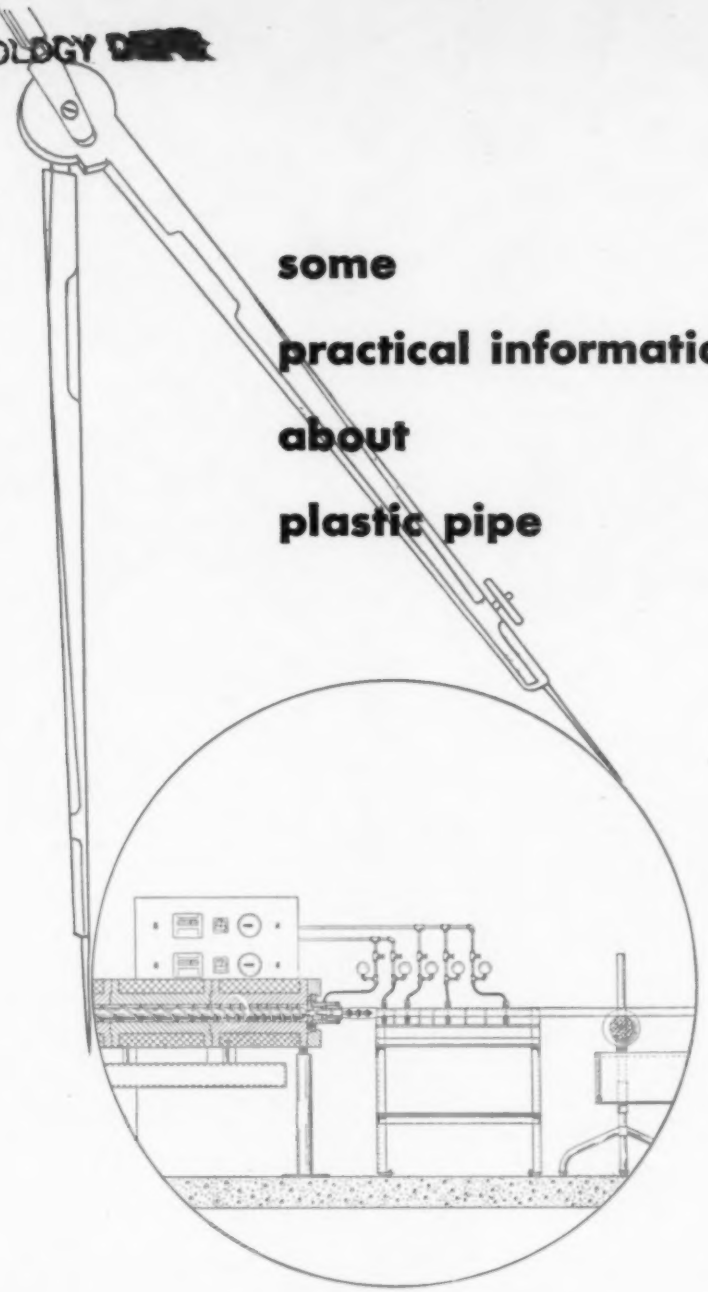
Open view of the essentially simple construction of the New Flat Master and standardized contact structures that provide 5 speed points in either direction.



Phantom view of one of 4 contact structures that are interchangeable with many other C-H masters and switches. Standardized, simplified, sturdy.

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 30, No. 4.

TECHNOLOGY DEPT.



some practical information about plastic pipe

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DETROIT

● In a plastic process unit you have these basic elements: extrusion; sizing; stress-relieving; cooling; cutting to length; inspection and packaging. In addition, there is also a reclaiming unit for rejected pipe.

Above you see an illustration of the heart of the plastic pipe processing unit . . . extruder with its die, sizing rings and take-off equipment. Herein lies the success or failure of the finished product.

To make plastic pipe, either rigid or flexible, you start with a choice of basic plastics. Today, there are several accepted basics, such as: modified polystyrene; butyrate; polyethylene and either rigid or semi-rigid polyvinyl chloride. Each of these plastics has specific qualities and individual characteristics. The type you use depends upon the end use to which the finished pipe is to be put.

We have been working with plastics and plastic pipe, and rubber, for many, many years. Our Extruders have produced many miles of plastic pipe. We can give you practical help in setting up either the basic process or the complete plant, designing and building the equipment. Before you undertake your plastic pipe project, consult with the people who know the business.

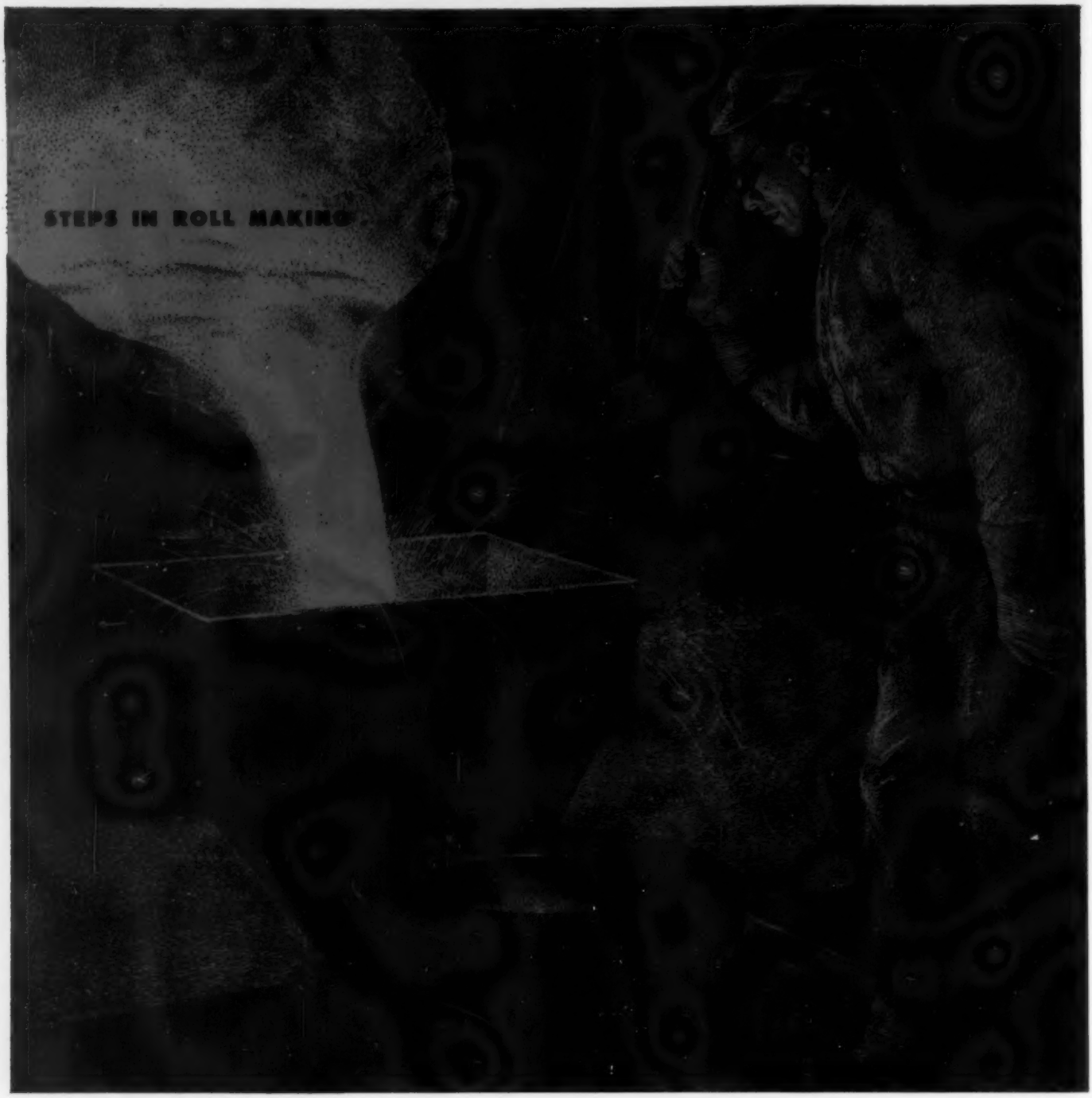
YOUR INQUIRY — If you want to be in the plastic pipe business, we can help you. A letter of inquiry will receive prompt and confidential attention.

National Erie products for the Plastic and Rubber Industries • Extruders • Simplex Doors for Autoclaves • Mills and Hydraulic Presses.

This old and well-known line of machinery was acquired March 1, 1952, by The Aetna-Standard Engineering Company. They are manufactured in their Warren, Ohio and Ellwood City, Pa., plants. The sales and engineering of the National Erie line is the responsibility of Hale and Kullgren, Inc., Akron, Ohio.

SALES and ENGINEERING by
HALE AND KULLGREN INCORPORATED
P. O. BOX 1231 - AKRON, OHIO

MANUFACTURING by
Aetna-Standard
THE AETNA-STANDARD ENGINEERING CO.
PITTSBURGH, PA.
Plants in Warren, Ohio
Ellwood City, Penna.



Pouring the Roll

WHERE EXPERIENCE COUNTS . . . for you

The critical step in roll making occurs in the pouring. Here, the experience and metallurgical knowledge of the roll maker determines the quality of the roll and its performance on your stands.

For more than forty years, National has been pouring rolls that are sound, long-wearing . . . rolls cast to the right hardness, chill depth and heat resistance, iron and alloy iron rolls that you can depend upon to give long tonnage life.

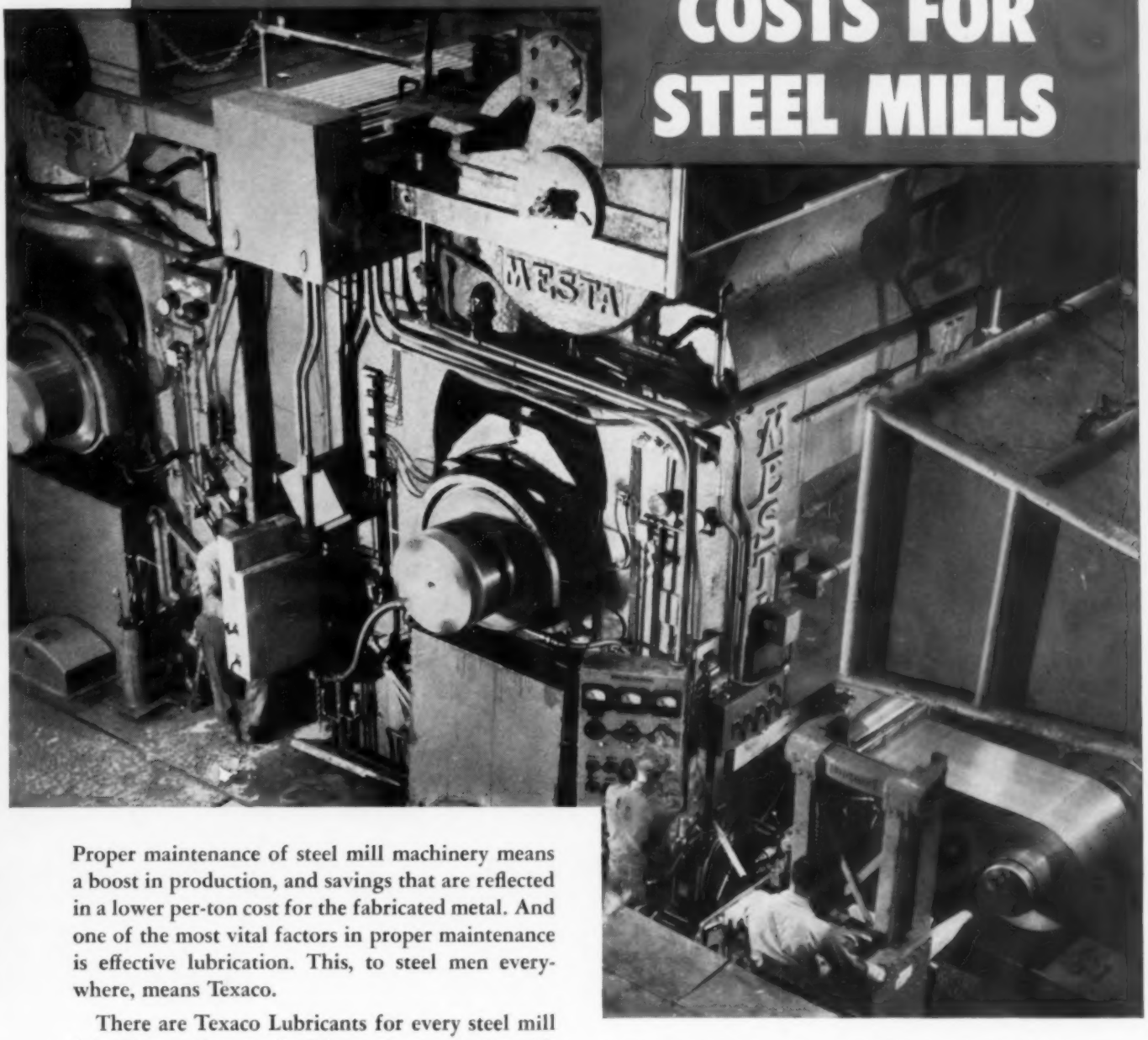
National Rolls

THE NATIONAL ROLL & FOUNDRY CO.

AVONMORE, PENNSYLVANIA

SPECIALISTS IN IRON AND ALLOY IRON ROLLS AND CASTINGS

HOW TEXACO REDUCES UNIT COSTS FOR STEEL MILLS



Proper maintenance of steel mill machinery means a boost in production, and savings that are reflected in a lower per-ton cost for the fabricated metal. And one of the most vital factors in proper maintenance is effective lubrication. This, to steel men everywhere, means Texaco.

There are Texaco Lubricants for every steel mill job. *Texaco Meropa Lubricant,* for example, with special Extreme Pressure properties to protect enclosed reduction gears. *Texaco Regal Oil* to guard oil film bearings on roll stands.

Along with these fine lubricants goes Texaco Lubrication Engineering Service. The men who render it are specially trained and widely experienced . . . skilled in diagnosing trouble and adept in overcoming it. Their service to you goes far beyond mere lubricant recommendations.

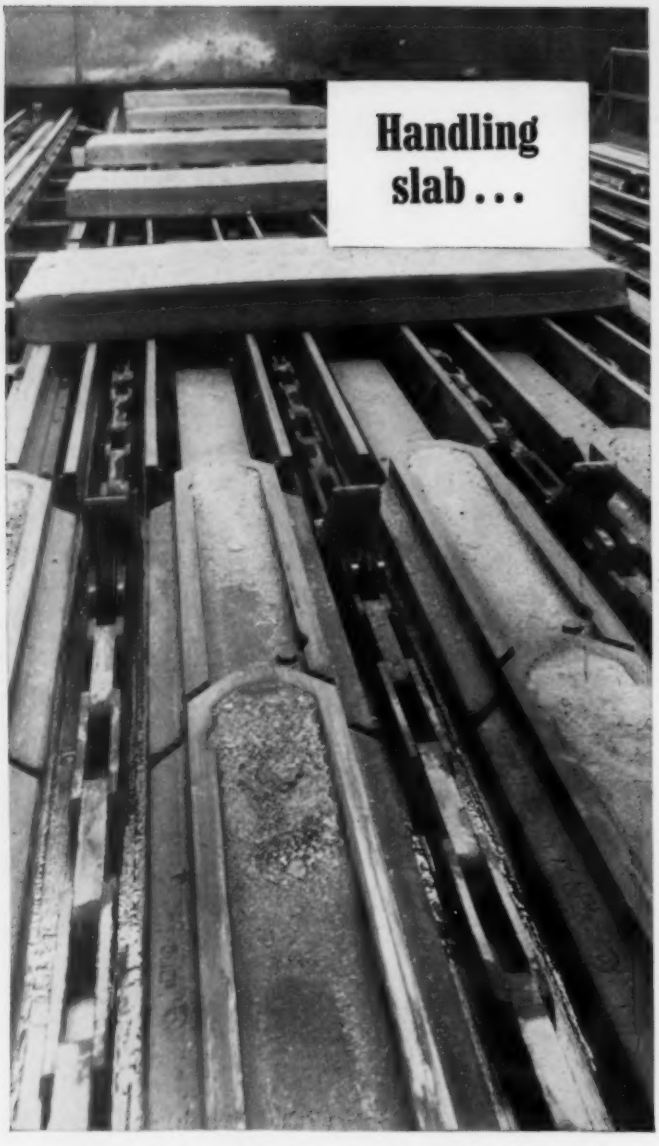
Let a Texaco Lubrication Engineer survey your mill and help you bring down costs. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Lubricants, Fuels and Lubrication Engineering Service

TUNE IN: Tuesday nights on television—the TEXACO STAR THEATER starring MILTON BERLE. See newspaper for time and station.



Link-Belt Chains and Sprockets move 8,000 lb. slabs at 60 ft. per min. along a transfer table. Slab temperatures as high as 1800° F are often reached.

At this mill, scrap is handled on a mechanized Link-Belt system. By reducing crane and vehicle movements in the vicinity of crews, safety is improved.

LINK-BELT conveyors help cut costs in steel production . . . every step of the way

IN MILLS all over the country, Link-Belt conveying systems provide important savings in the making of steel. Along every step of the way—from mine to finished product—this fast, safe, economical transportation reduces scrap losses, increases yield.

Slab and scrap handling are but two of the instances in which Link-Belt equipment increases yield and cuts production costs. Link-Belt conveyors offer similar economies for moving coils weighing up to 75,000 lbs. . . . for raw bulk materials, rods, billets, plates, pipe.

Link-Belt engineers will work with your own engineers, consultants and builders of mill and process equipment. Together, they can give you a conveying system built to your exact requirements.

LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa), Sydney (Australia). Offices in Principal Cities. 12,840

Alliance

FIRST IN SIZE
FIRST IN CRANE DESIGN

● We produce big and unusual cranes. We're delighted with unheard of and almost impossible applications for cranes. For example, above is a 270-ton gantry crane installed fifteen years ago on this dam. Successful operation of the dam depends on the crane. Similarly, other huge installations depend on **big Alliance cranes.**

On this crane two 135-ton trolleys can act independently or in combination when lifting loads in excess of 135 tons. One trolley is equipped with a 20-ton auxiliary hoist to handle lighter loads.

For fifty years, Alliance has been designing, engineering and building giant cranes for heavy industry. Where unusual types of cranes are required—for any service—Alliance engineering experience and diversified background of its personnel is generally sought.

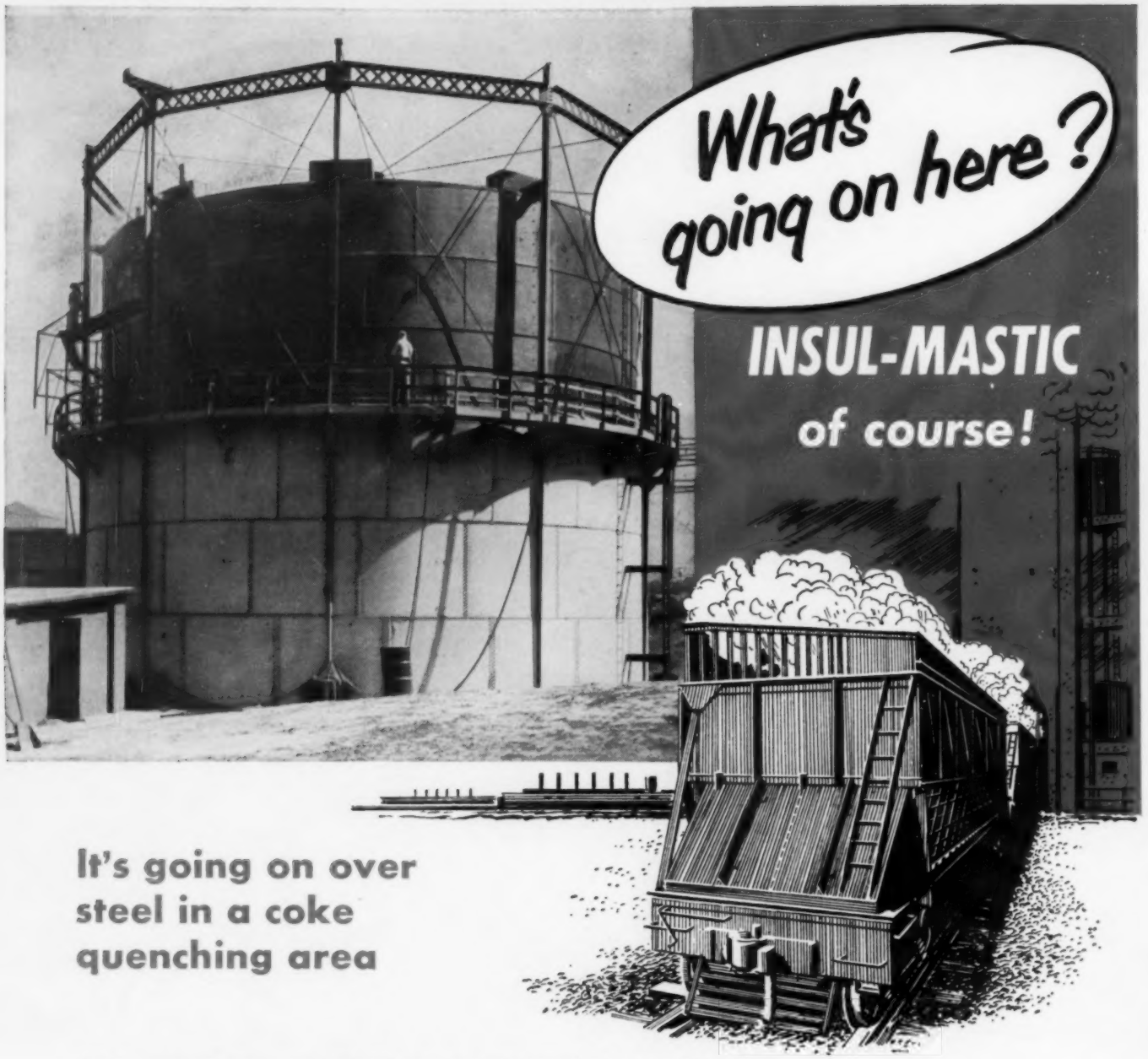
Thousands of Alliance cranes are on the job today hoisting and shifting gigantic loads . . . safely, smoothly, quickly, economically. Always rely on Alliance to give your plant dependable extra lifting power.

BIG
CRANES

THE ALLIANCE MACHINE COMPANY

MAIN OFFICE
ALLIANCE, OHIO • PITTSBURGH OFFICE **1622 OLIVER BUILDING, PITTSBURGH, PA.**

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STANDARD FABRICATED

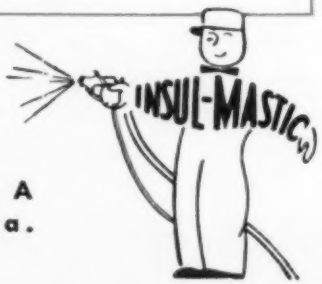


It's going on over steel in a coke quenching area

Acid vapors from quenched coke constantly attack this gas holder. In the steel mill where it is located, quenching water is used over and over. Therefore, the vapors are heavily acid laden. Corrosion is fast and severe, but INSUL-MASTIC coatings have given protection in this mill for years. That's why INSUL-MASTIC is "going on" this new tank . . . it has proven that it stops acids, alkalis and moisture.

Steel mills throughout the country are doing the same thing. On new and old coke batteries and all nearby equipment INSUL-MASTIC is being specified as the protective coating. Wherever there are vapors from quenched coke INSUL-MASTIC men are working with steel men to prevent corrosion. The INSUL-MASTIC representative near you can help you prevent corrosion in your mill as these *Superior* coatings have done in other steel mills. Write today for his address.

To control condensation on cold tanks and pipes use INSUL-MASTIC TYPE "D".



Think First of the Coatings that Last!

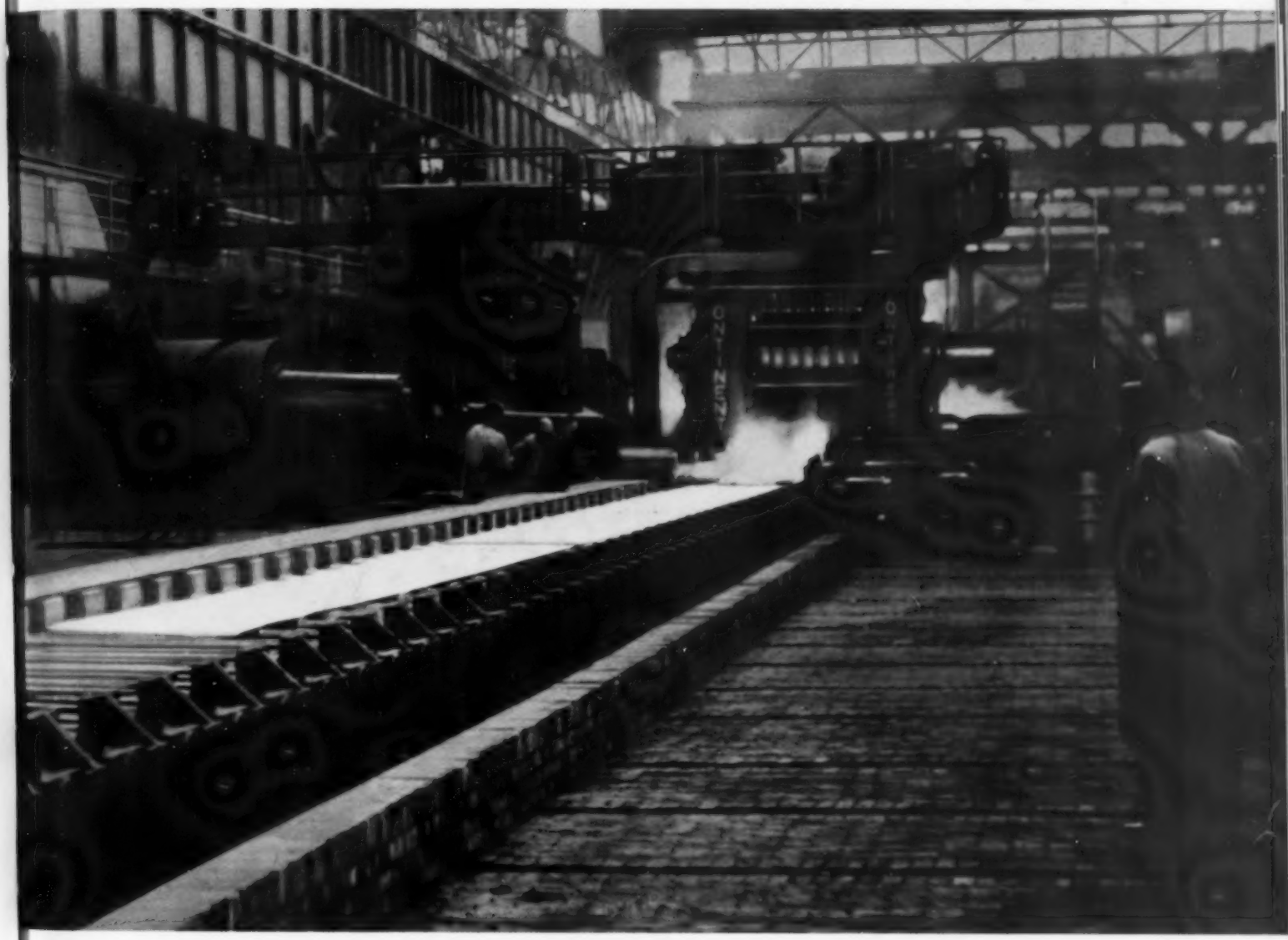
Insul-Mastic

CORPORATION OF AMERICA
Oliver Building • Pittsburgh 22, Pa.

Representatives in Principal Cities

CONTINENTAL

FOUR-HIGH REVERSING MILL



Complete Rolling Mill Installations

SLABBING MILLS	Mills complete with Auxiliary Equipment	BLOOMING MILLS
UNIVERSAL MILLS		STRUCTURAL MILLS
PLATE MILLS	★ ★ ★	RAIL MILLS
HOT STRIP MILLS	CONTINENTAL CHIPPER	BILLET MILLS
COLD STRIP MILLS	ROLL LATHES	ROD MILLS
TEMPER MILLS	SPECIAL MACHINERY	MERCHANT MILLS

CASTINGS—carbon and alloy steel from 20 to 250,000 pounds

ROLLS—iron, alloy iron and steel rolls for all types of rolling mills

WELDMENTS—fabricated steel plate, or cast-weld design.

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Foundry & Machine
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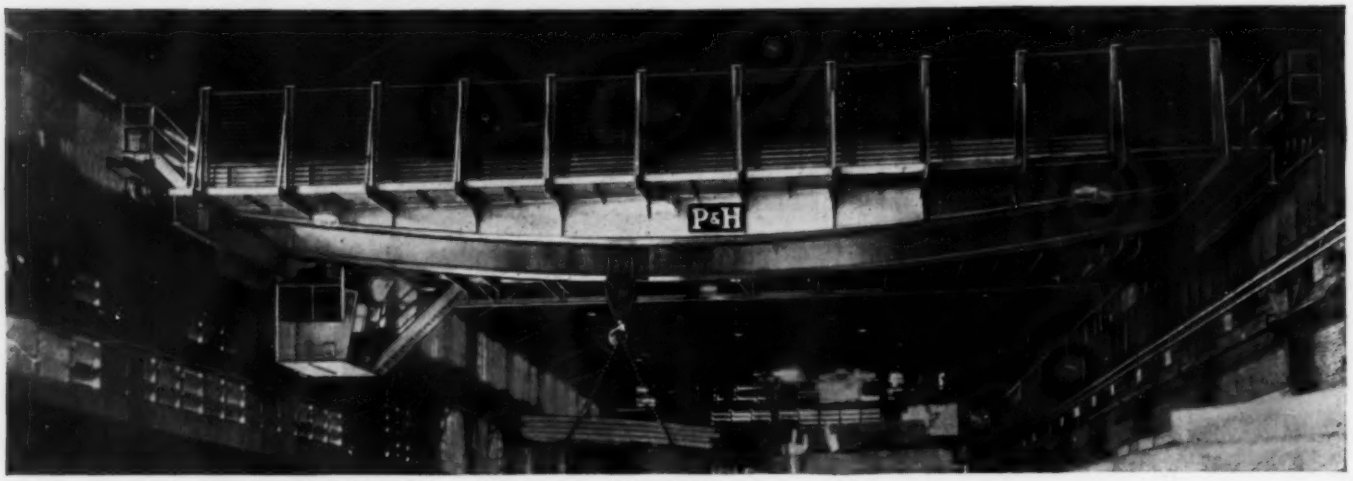
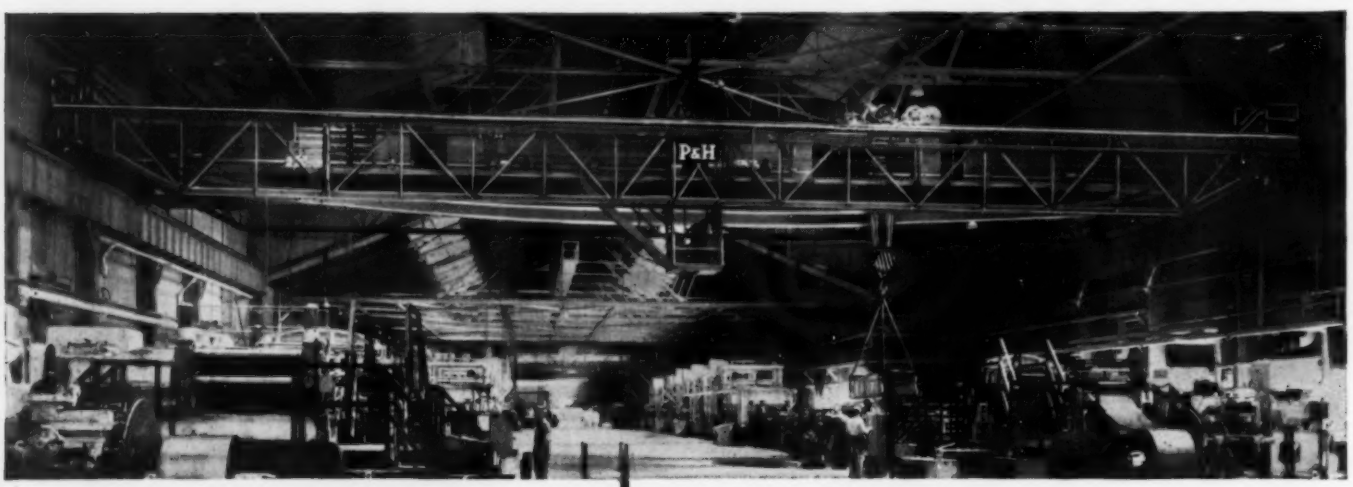
NORTH..SOUTH..EAST..WEST..EVERYWHERE!



P&H

STEEL MEN PREFER
MILL TYPE CRANES
for longer, finer service

Now, the number is well over the 2000 mark — more and more P&H Cranes serving the steel industry. There's good reason for the preference steel men put in P&H . . . and that is *performance*. It's measured in longer years of service, in lower costs, in more dependable operations. Learn more about P&H Mill Type Cranes. Write for your copy of Bulletin C-42.



P&H ...ahead in added values

3-Gear Case Bridge Drive — for perfectly equalized motive power.

No Open Gears at Trucks — gear reductions are fully enclosed, running in oil.

Flexible Couplings at Wheel Shafts — for smoother starts, longer bearing life.

Split Gear Cases — easier inspection and maintenance.

Large Diameter Cross Shaft — greater strength, lower torque to minimize strain.

Hoist Sheaves — readily accessible from trolley deck. All hoist gears, including drum gear and pinion, run in oil.

P&H Motors, brakes and controls available.

P&H OVERHEAD CRANE DIVISION

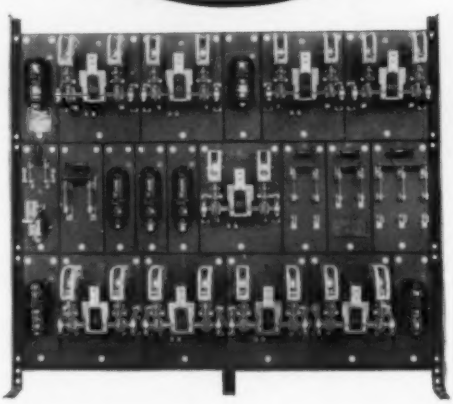
HARNISCHFEGER CORPORATION

Milwaukee 46, Wisconsin

POWER SHOVELS • CRAWLER AND TRUCK CRANES • OVERHEAD CRANES • HOISTS • ARC WELDERS AND ELECTRODES • SOIL STABILIZERS • DIESEL ENGINES • PRE-FAB HOMES

One of two 15-Ton Drave Unloaders, at eastern seaboard city, both equipped with Control by EC&M.

The TIME-CURRENT Acceleration Relay has only one moving part, which is magnetically centered in its short movement.



The d-c series motor speeds up quickly when lightly-loaded . . . automatically adjusts itself to a slower speed and increases motor torque when the load is heavy.

There is no other system of control which matches these series motor characteristics like EC&M TIME-CURRENT Acceleration Relays. Long-time for accelerating heavy loads—shorter-time for a light load, and the relay adjustment remains *unchanged*.

This self-adjusting feature is an *exclusive* characteristic of EC&M TIME-CURRENT Control. Operators use it to advantage in taking the swing out of a load, for fast re-acceleration to full speed when coasting, and when called upon to make short, quick moves.

And don't overlook the fact that these relays stay in adjustment—thousands of them are in service with the original factory setting untouched.

IT PAYS TO SPECIFY EC&M CONTROL

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

You can maintain more of the FULL-RATED PRESSURE

with ZURN Engineered Low Pressure Drop STRAINERS

Plug Relieving Yoke assures easy valve operation since the plug can be unseated before turning.
"C" washer and yoke cover closures facilitate rapid cover removal for cleaning.
Minimum open area ratio of 6 to 1 maintained even though selected basket material may be only 30% open.
Eccentric location of baskets creates a flow cross-section proportional to the flow at all points in the screen cavity, thus reducing turbulence and flow resistance at that critical point.

Zurn LPD Duplex Plug Type Strainers permit high rates of flow with remarkably low pressure drop and immeasurably improve the handling of fluids such as oil, chemicals, water through pipe lines.

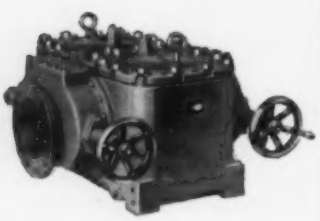
Zurn Low Pressure Drop (LPD) Strainers are design improved for correct circularity. They have ample waterways; smooth inner walls; correctly sized and perforated baskets, eccentrically positioned, all of which combine to reduce pressure loss and afford maximum protection for all types of mechanical units connected with pipe lines. Zurn LPD Strainers are held to close tolerances for materials, shapes, and dimensions, assuring the utmost in strength and safety and continuous operation.

Zurn LPD Strainers are widely used to protect close-tolerance control devices and delicate mechanisms, also to protect product purity. They make continuous production processes possible.

Zurn LPD Strainer applications include fluid handling lines for lubricating and fuel oil, and oil during the refining process; a wide range of chemicals produced and used by the various process industries; public utility power plants; power stations; industrial plants; ships and high-temperature installations. Zurn Fluid Handling Engineers are available for consultation on your particular problem.

J. A. ZURN MFG. CO.
INDUSTRIAL DIVISION
ERIE, PA., U.S.A.
In Canada: Canadian Zurn Engineering Ltd., Montreal 25, P. Q., Canada

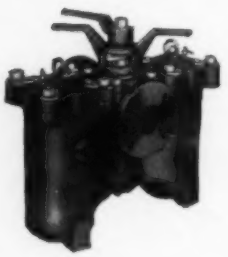
There is a ZURN LPD strainer for every fluid handling purpose



Zurn Duplex Gate Type Multi-Basket Strainer.

Zurn Sinlex Strainer. Available in offset and straight-through types.

Zurn "Y" Type Strainers available in any cast material and for high pressures.



Zurn Duplex Plug Type Strainer.

Zurn Engineered Low Pressure Drop Strainers are patented and patents pending.

WRITE FOR LPD STRAINER MANUAL DATA NO. 952

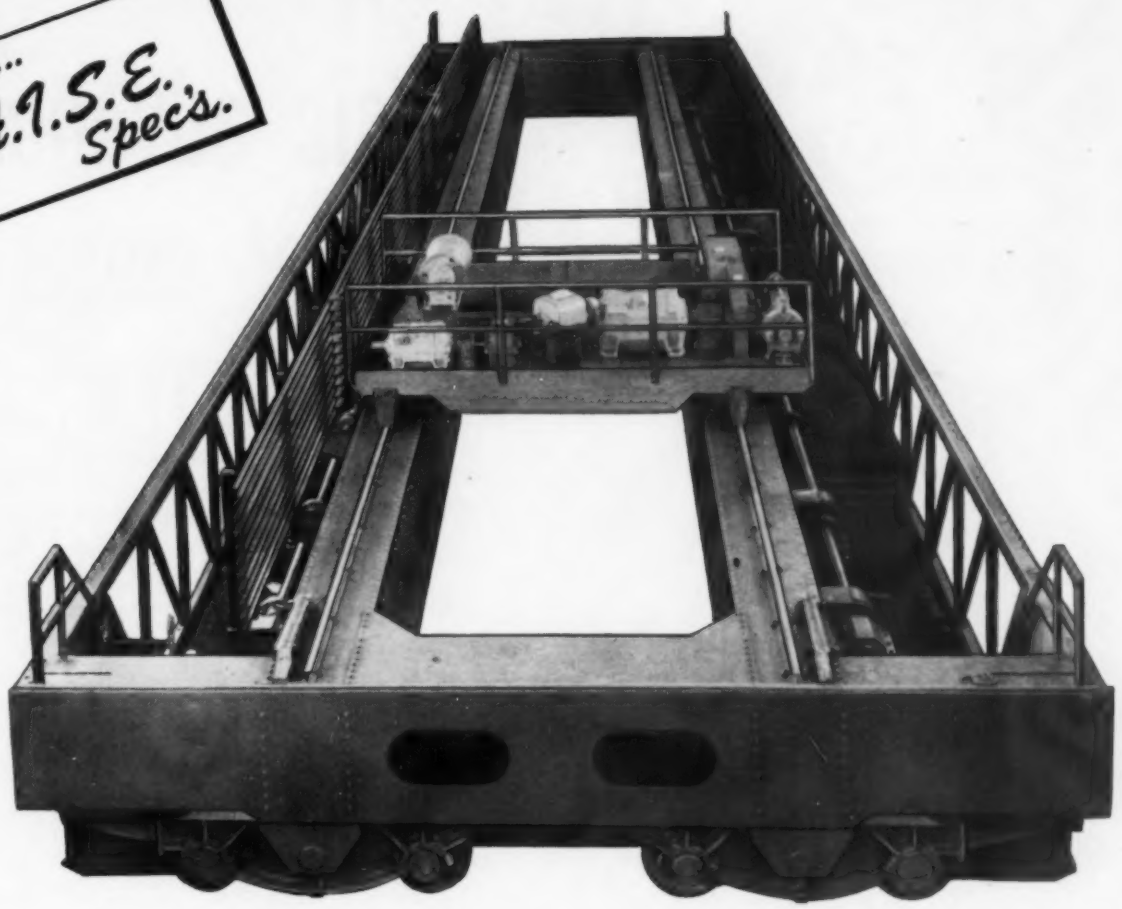
This manual includes previously unpublished pressure drop data and gives useful, factual information on fluid handling.

J. A. ZURN MFG. CO.
Industrial Division, Erie, Pa., U. S. A.
Please send me Zurn LPD Strainer Manual Data No. 952.

Name _____
Position _____
Company _____
Street _____
City and State _____
Please attach coupon to your business letterhead—Department ISE

Copyright 1953

to... A.I.S.E. Spec's.



STEEL MILL CRANES . . .

by "Shaw-Box"

This 25-ton "Shaw-Box" Crane, 100'-0" span, was built to A.I.S.E. standard No. 6 specifications. When your cranes are by "Shaw-Box" to these specifications, you get more crane for your crane dollar as you pay less for engineering. "Shaw-Box" already has standard A.I.S.E. designs for cranes ranging from 15 to 100 tons capacity.

In "Shaw-Box" Cranes, you get cranes built exactly to your specifications plus the advantages of "Shaw-Box" engineering, manufacturing techniques, fine workmanship, performance, and maintenance conveniences that have built an enviable reputation for all "Shaw-Box" equipment.

SEND ALL YOUR INQUIRIES FOR CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX".

MANNING MAXWELL & MOORE INC. TRADE MARK

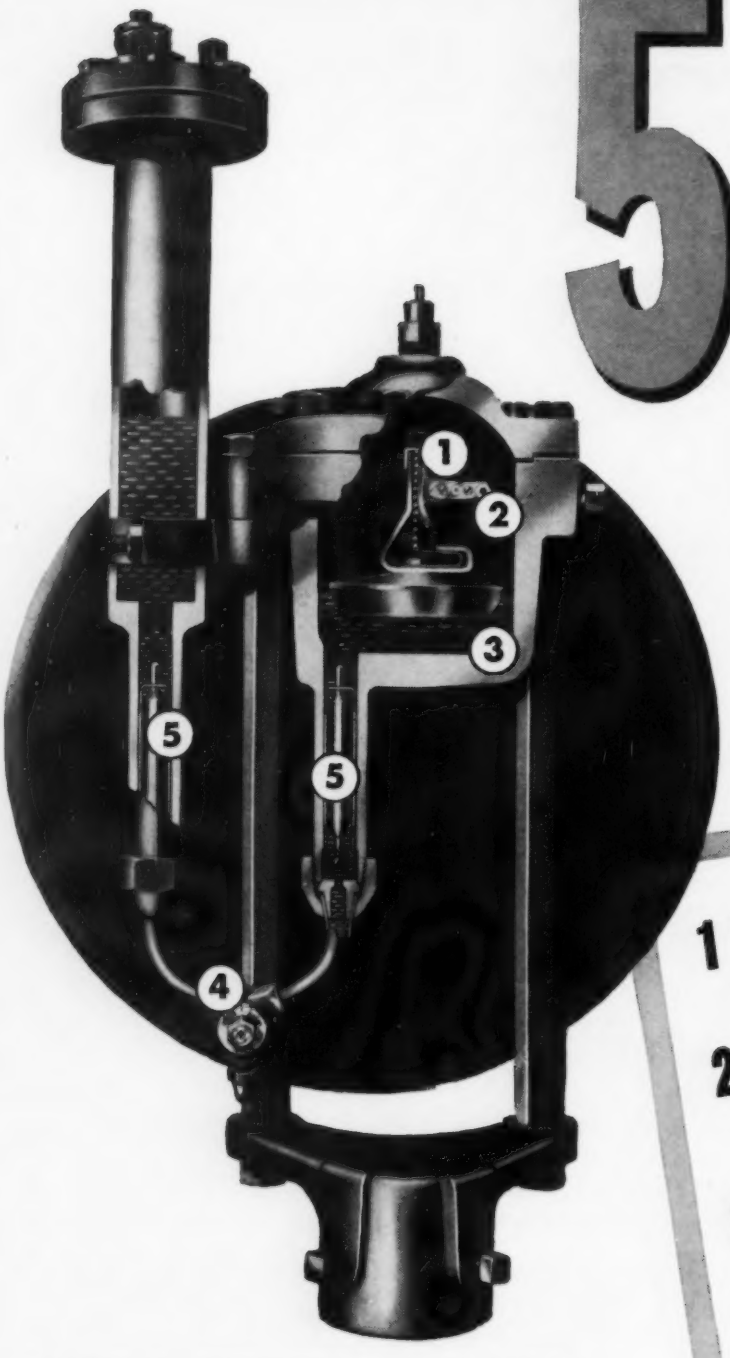
"Shaw-Box" CRANES

MANNING, MAXWELL & MOORE, INC.

Muskegon, Michigan

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, and 'American' Industrial Instruments.

5 basic advances that mean BETTER FLOW METERING!



1 New Segmental Drive Assembly — stainless steel ball-type chain insures perfect alignment and friction-free travel of float.

2 New Pressure-Seal Bearing — stainless steel with exclusive seal ring . . . gives unmatched freedom at any working pressure from friction, maintenance and leaks. No lubrication required.

3 New Compact Float Chamber — greater accessibility for easier, quicker cleaning.

4 New U-Bend and Damping Plug Assembly — self-aligning, all-welded construction . . . no gaskets required. Calibrated damping plug fully adjustable under pressure. Directed drain for mercury at lowest point.

5 New Check Floats — with positive-seating stainless steel ball plug. Submerged in mercury for complete protection against dirt and corrosion.

With major improvements in every basic detail, the complete new line of Foxboro Flow Meters now gives metering performance that's farther ahead of the field than ever before!

In addition to the outstanding advances illustrated, these new meters incorporate many other superior features, including: interchangeable parts; large floats with long travel for added power; and float in high pressure chamber to minimize ambient temperature effects.

Write for new Bulletin 460. It describes the complete new line . . . indicators, recorders, controllers, transmitters . . . with round or rectangular cases . . . with and without integrators. The Foxboro Company, 584 Neponset Ave., Foxboro, Mass., U.S.A.

FOXBORO
Reg. U. S. Pat. Off.
First in FLOW METERS

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

WILSON RADIANT CONVECTOR FURNACES

The recent expansion in the high carbon strip department of John A. Roebling's Sons Corporation, Trenton, New Jersey, includes this installation of Wilson radiant convector furnaces. It is comprised of two furnaces and six bases for a charge size 42" diameter x 102" piling height. New performance records for fast and uniform heating of coils for spheroidization are being established by this equipment.

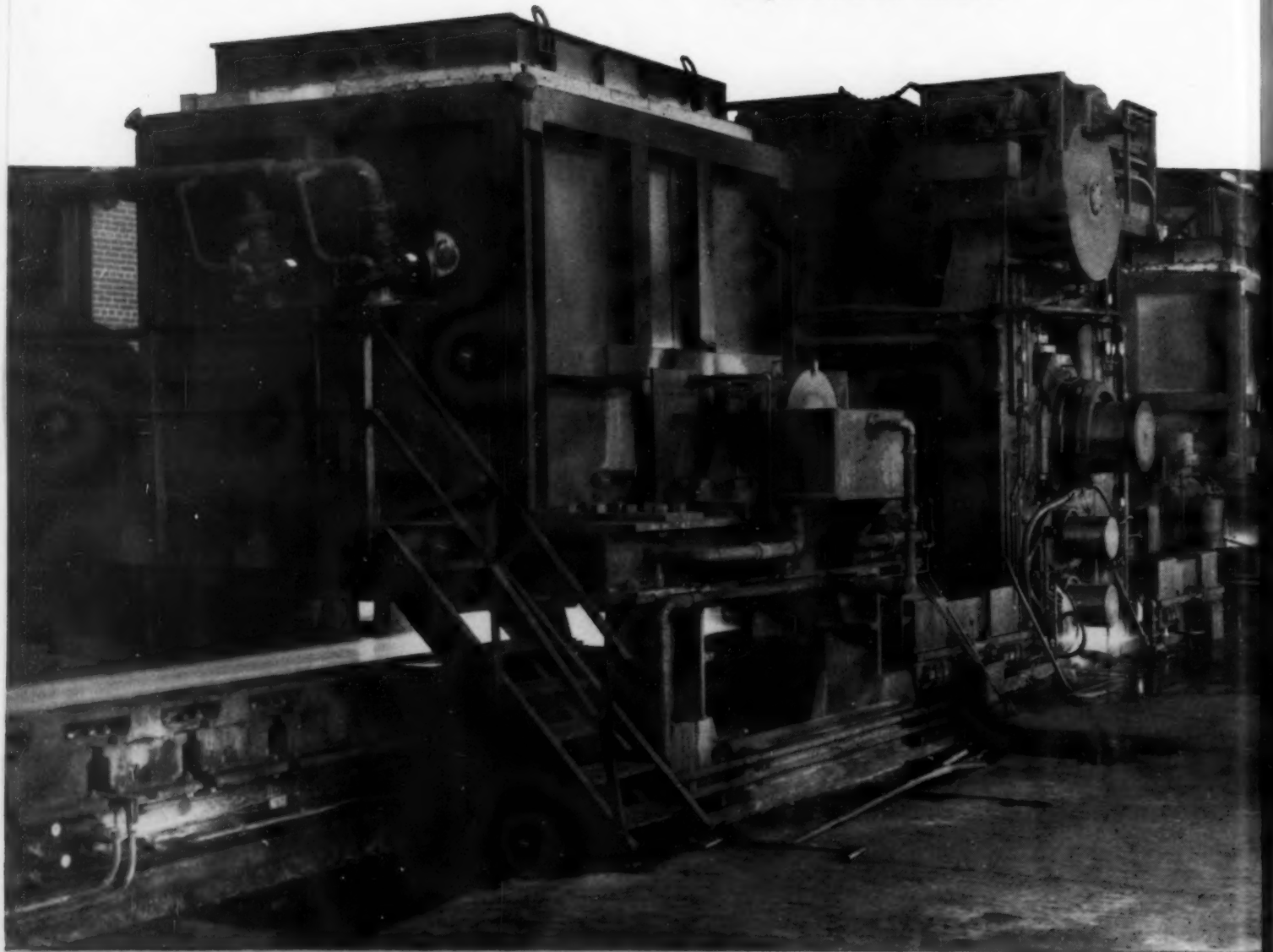
Lee Wilson

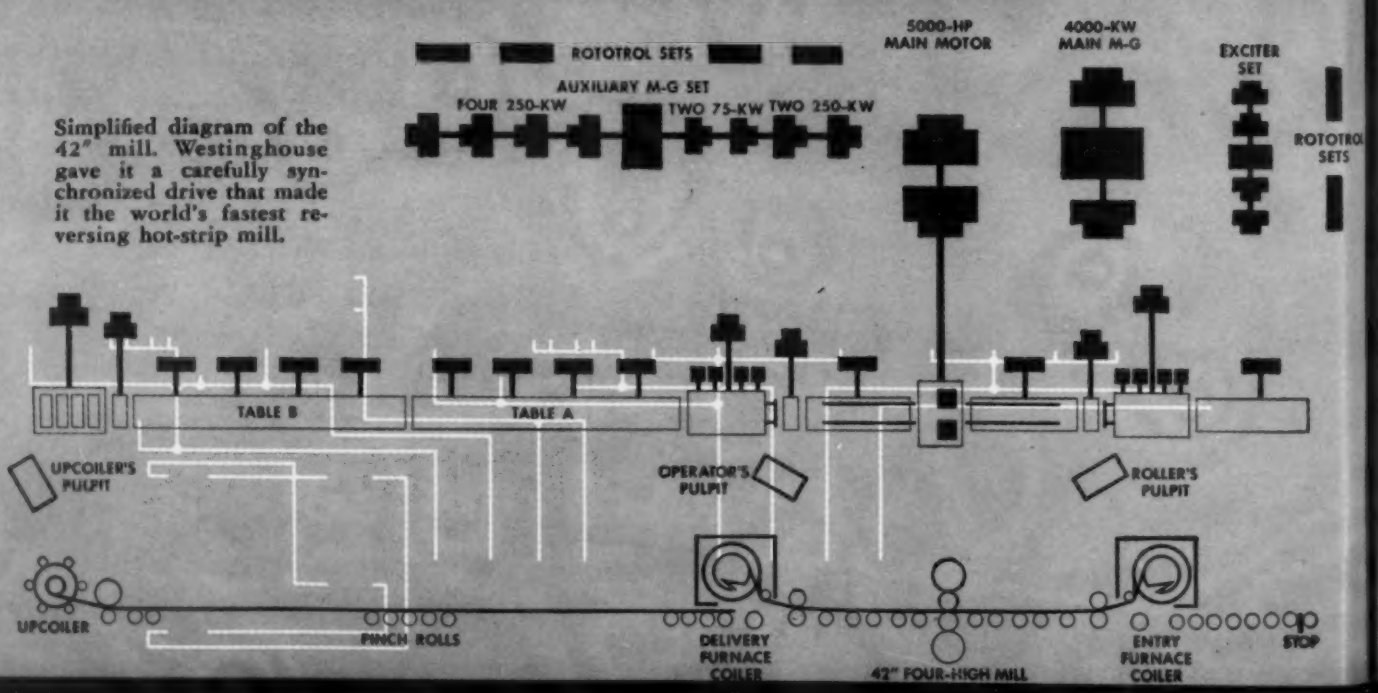
ENGINEERING Co., Inc.

20005 WEST LAKE ROAD • CLEVELAND, OHIO
Telephone ED-1-6600

BELL TYPE FURNACES ★ RADIANT TUBE HEATING ★ ANNEALING PROCESSES

They did what you can do to produce more





Simplified diagram of the 42" mill. Westinghouse gave it a carefully synchronized drive that made it the world's fastest reversing hot-strip mill.

Can you use hot-strip mill experience like this?

Five of the seven recent reversing hot-strip mill drives in U. S. mills have been built by Westinghouse. Here's a good example—a mill installed in 1949 that was *50% faster* than any previous mill.

An exceptionally high-speed reversing mill

This mill has been highly successful. Theoretical maximum speed is 2,000 fpm and it has operated at more than 1,500 fpm. A complete ingot can be reduced to strip in one piece and the mill regularly produces coils weighing 16,000 to 20,000 lbs. Finished thicknesses range from 0.125″ down to 16 gauge.

Special double-armature motor for main stand

Engineering the drive for this mill presented tricky problems. To accommodate the high speeds and wide speed range, Westinghouse developed a special double-armature motor, each unit of which is supplied by its own d-c generator. Both these generators are driven by a synchronous motor. A second M-G set is used to supply the auxiliary drive.

Main and auxiliary drives synchronized

When the strip leaves the roll stand it races into a narrow groove in a furnace coiler mounted near the mill. This demands the most precise synchronization between main drive and auxiliary drive. Westinghouse answered the need by carefully matching all drive elements and co-ordinating the whole system with Rototrol® regulators.

Call Westinghouse early on your next project

Westinghouse can apply more experience to drives for reversing hot-strip mills than any other manufacturer. And that's typical of our steel mill service. When your next job comes up, call in Westinghouse early.

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YOU CAN BE SURE...IF IT'S

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EQUIPMENT FOR STEEL PRODUCTION

Here's where

THERMIT WELDING STOPPED THE CLOCK!

Weeks of idle time saved in returning pinion to duty...

When a piece of vital equipment breaks down, Thermit Welding stops the clock on idle time — enables quick, economical repairs on a variety of parts. Only a *minimum* of technical skill is required.

See the time-saving repair made on the 48" mill pinion shown above. The 28" neck was Thermit welded — and the pinion was back in operation *weeks* before a replacement could be obtained.

WAITING FOR REPLACEMENT PARTS COSTS TIME AND MONEY!

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WITH GEARS RUNNING IN OIL

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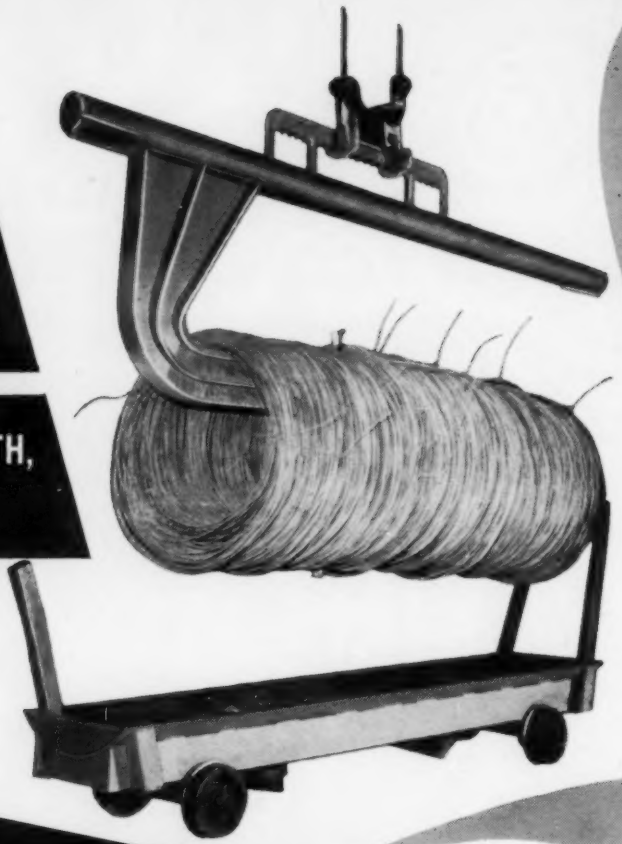
WELDCO MONEL HOOKS PROVE THEIR SUPERIORITY

FOR LONGER LIFE, GREATER STRENGTH, EXTRA CORROSION-RESISTANCE



IT'S WELDCO RIGHT DOWN THE PICKLING LINE!

SEVERAL YEARS AGO, a Joliet wire mill ordered 4 Weldco Monel pickling hooks. These hooks soon proved so superior to heavy cast hooks (also in use) that 16 more were installed, and the cast hooks were diverted to lighter service. So once again, as in many other cases, Weldco replaced heavy, old-style hooks right down the pickling line. The reason: Weldco hooks are stronger, lighter in weight, easier to handle, more corrosion-resistant, and carry heavier loads.

The Weldco pickling hook shown above carries 5,000-lb. loads easily . . . has a special notched lifting "bale" for use with a double-crane hook. This design helps balance the load—makes possible rapid, efficient handling, with less manpower needed. Weldco engineers built this hook to meet the requirements of one particular mill, and can do the same for **your** plant.

Depend on Weldco's ingenuity and years of fabricating experience, for all your pickling and liming equipment. Whether you need conventional lightweight Monel hooks or special adaptations, Weldco engineers design and build to meet your exact requirements. For complete pickling information, get in touch with us today.

WELDCO

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY

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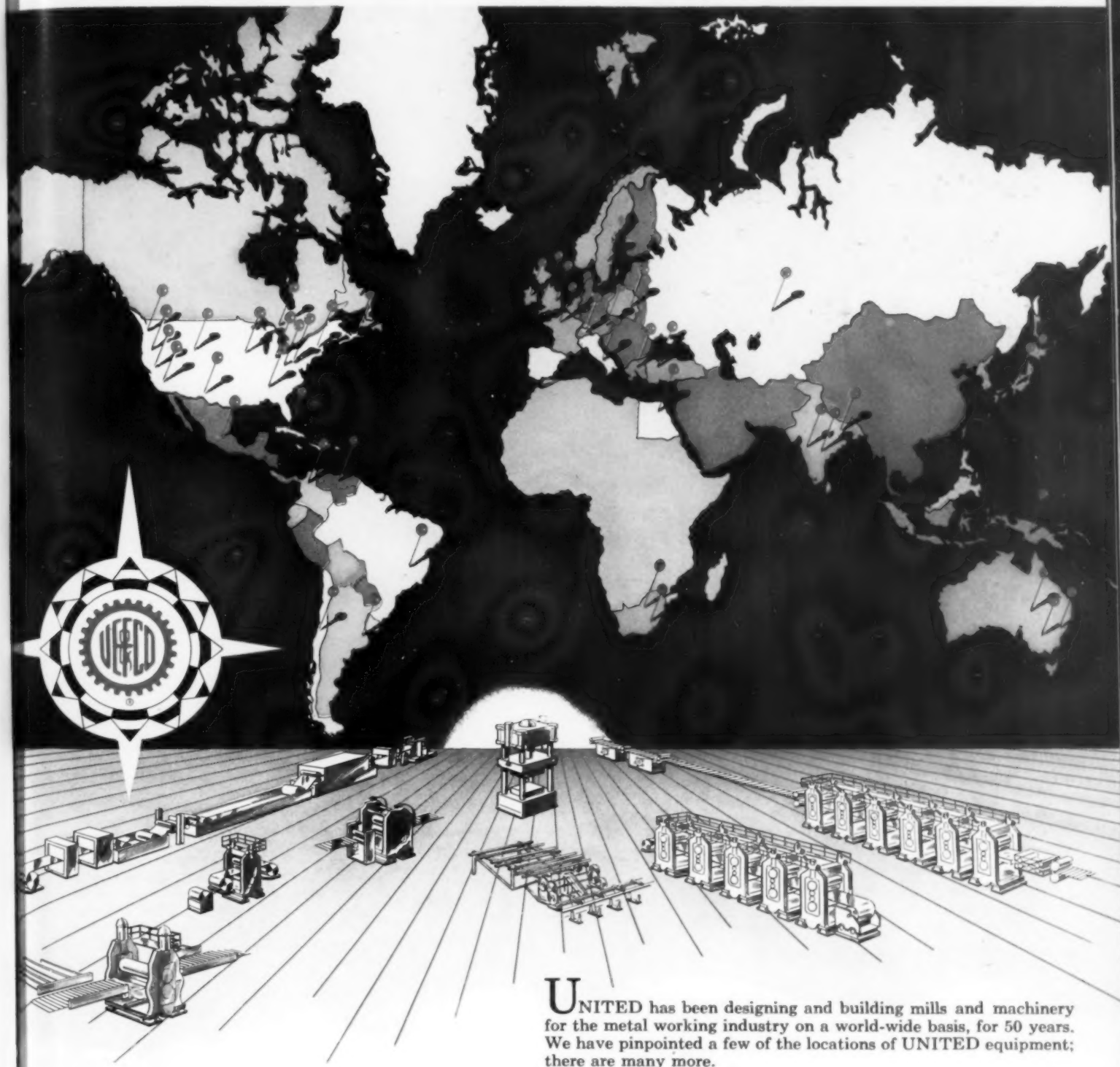
UNITED CAN SERVE YOU . . . NO MATTER WHERE IN THE WORLD YOU ARE



UNITED has been designing and building mills and machinery for the metal working industry on a world-wide basis, for 50 years. We have pinpointed a few of the locations of UNITED equipment; there are many more.

Inquiries concerning modern rolling mills and metal processing equipment are solicited from mill operators everywhere; for no matter where in the world you are—at home or abroad—UNITED can serve you.

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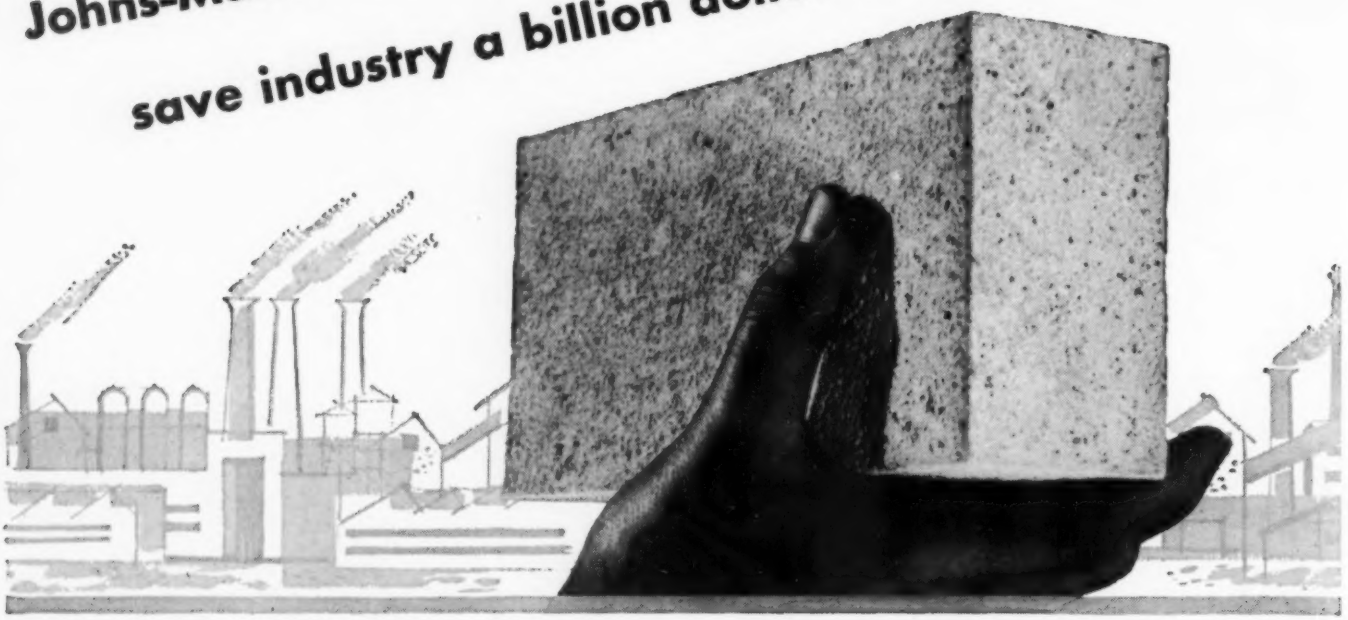
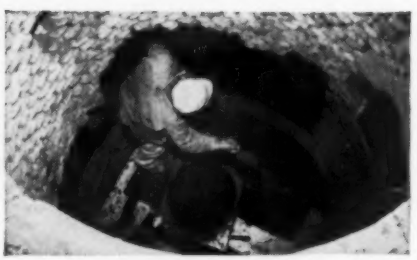
Johns-Manville Insulations save industry a billion dollars in fuel every year!



Reduce your fuel costs and build better furnace linings with JM-3000 INSULATING FIRE BRICK

HERE'S THE ONLY insulating fire brick that withstands a full 3000F. It's highly efficient both as an exposed refractory lining or as back-up insulation. And JM-3000 is only one of six types of Johns-Manville Insulating Fire Brick made for these applications. All provide long-life insulation. All are light in weight, have low conductivity, high structural strength. These properties permit thinner furnace walls—yet you can achieve important fuel savings and increased production, because J-M Insulating Fire Brick assures quick furnace response.

Sil-O-Cel* Insulating Brick is another outstanding J-M fuel-saver . . . a high load-bearing brick for back-up insulation behind refractory linings. It comes in three types, for service through 2500F—makes it possible to reduce the necessary thickness of refractory linings as much as one-third.



Save fuel with J-M Hydraulic Setting Refractories

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Save Fuel with J-M Aggregates and Fills

These lightweight insulations are used as fills to conserve heat in irregular spaces where other forms of insulations cannot be economically applied. They are also used as aggregates for mixing with other materials to form insulating refractory concrete.

*Reg. U. S. Pat. Off.

Send for your free copy! This new booklet IN-115A gives full details about J-M insulating materials for service through 3000F. To find out how they can help cut your fuel costs, simply mail coupon.

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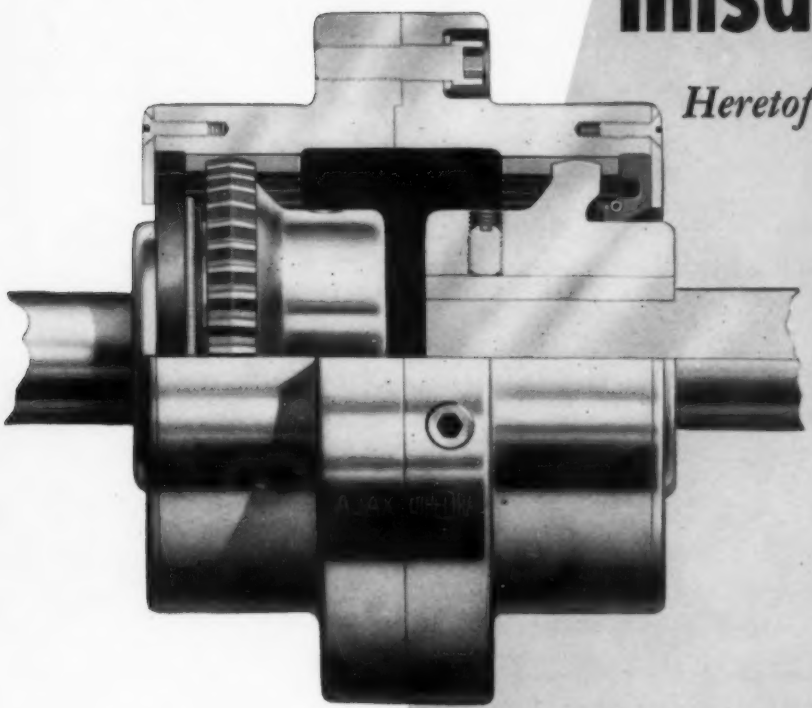
FLEXIBLE COUPLINGS

provide for AND protect against misalignment

Heretofore Considered Excessive



Ajax Dihedral surfaces of gears provide maximum bearing area and do not tend to rupture the oil film. This contributes to long life, cool running and quiet, chatter-free operation.

All gear teeth hardened to 50 to 55 Rockwell C.

* The performance of Ajax Dihedral Couplings confirms the fact that *there is no competition with quality.*

Design, installation and maintenance men are saving thousands of hours, and dollars by eliminating necessity for precision alignment of direct-connected machines.

New and exclusive Ajax Dihedral tooth shape provides for extreme misalignment with tooth clearance (backlash) kept to oil film requirements. Long life is assured because more tooth contact is maintained under operating conditions.

Positive oil seals keep lubrication in and dirt out.

Write for Bulletin 50.

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WESTFIELD, NEW YORK

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CARS

FOR
STEEL MILL INDUSTRY
WELDED CONSTRUCTION
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SLAG CARS - SINGLE POT
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SPECIAL CARS DESIGNED
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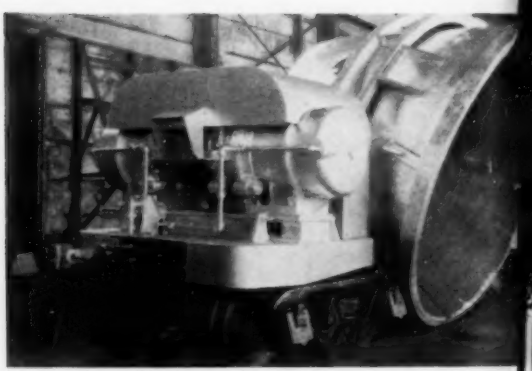
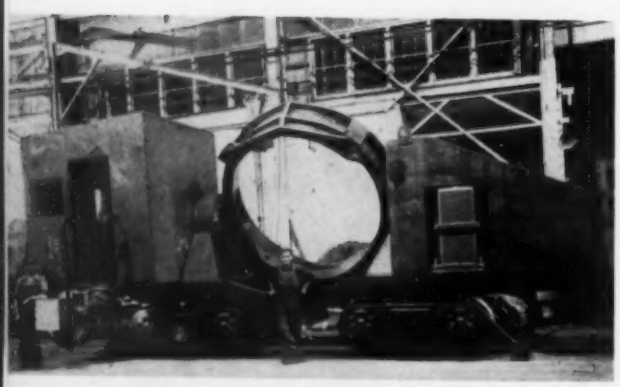
Mechanical Dumped Twin Pot Slag Car



400-Cu. Ft. Slag Car



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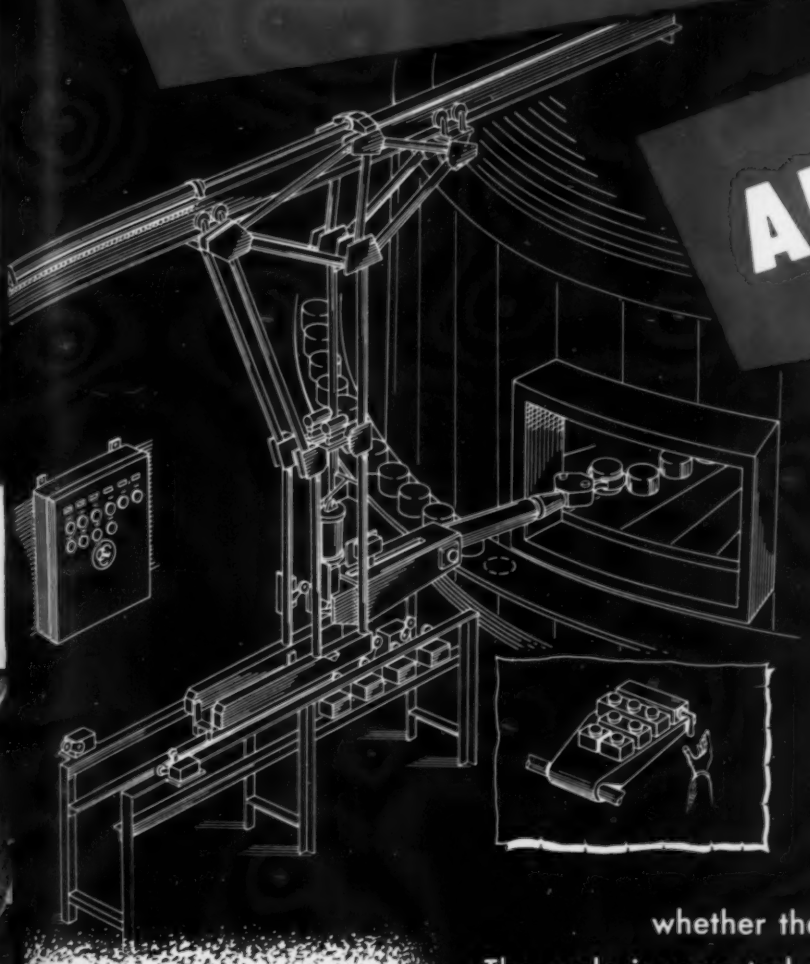
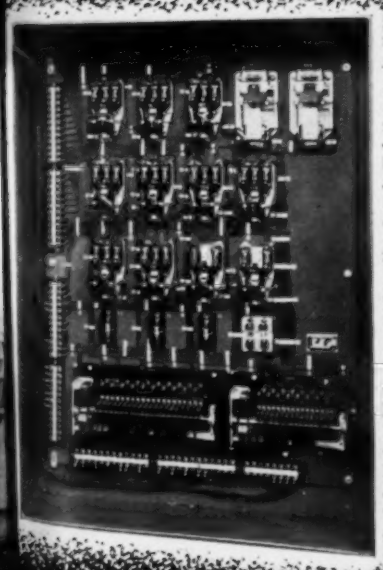
DESIGNERS, FABRICATORS AND ERECTORS OF STEEL MILL EQUIPMENT

How's This For — AUTOMATION?





This mechanical hand is called a Billet Charging Machine. It automatically loads cylindrical steel billets into a rotary furnace, one row at a time, to be heated for forging.

The machine picks up a billet from the conveyor and sets it down inside the furnace. It repeats this operation until it has lined up a full row of billets. A selector switch determines whether there shall be three or four billets to a row. The cycle is repeated when the furnace rotates to the next loading position.

Seven separate motions are required to load each billet. Thus the complete cycle involves either 21 or 28 individually controlled motions for the row.

The Billet Charger was designed by E. Homer Kendall, Consulting Engineer, of Alliance, Ohio and built by May-Fran Engineering, Inc., of Cleveland. The special automatic control panel — the brain of the machine — is Clark designed and Clark built.

You can put CLARK Engineered Electrical Control experience to work for you. Just contact your nearest CLARK representative.

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The NEW T-H Exide-Ironclad

★ 20% more capacity in the same space

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Heavier demands on all types of battery-powered haulage equipment dictate the need for batteries with greater capacity.

The new Exide-Ironclad T-H battery gives 20% more capacity in the same space—WITHOUT SACRIFICE OF LONG LIFE for which Exide-Ironclad Batteries are famous.

This new T-H battery is of the time-tested Exide-Ironclad construction, employing the exclusive slotted tube positive plate. New materials have made structural changes possible, which permit the use of larger positive plates—resulting in increased capacity.

The T-H line of Exide-Ironclad Batteries includes capacities for all battery-powered haulage units.

Now—more than ever before... YOUR BEST POWER BUY AT ANY PRICE!

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"EXIDE", "EXIDE-IRONCLAD", "SILVIUM", "PORMAX", *Reg. T.M. U.S. Pat. Off.*

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THESE FEATURES CONTRIBUTE TO THE HIGHER CAPACITY AND LONGER LIFE OF THE T-H BATTERY
LARGER POSITIVE PLATES
of exclusive Exide-Ironclad slotted tube construction.
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cast with the heavy top cross bars, are of SILVIUM, which resists corrosion — contributing to longer battery life.
SLOTTED PLASTIC TUBES
of non-oxidizing polyethylene—retain active material in contact with spines, yet permit the electrolyte to penetrate throughout the active material.
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This acid-proof plastic sealer fits snugly into the bottom of positive plate tubes, sealing in the active material for a longer working life.
EXTRA HEAVY NEGATIVE PLATES
to balance the new positive plates.
PORMAX SEPARATORS
Practically indestructible. Decrease internal resistance, thus assuring quick starting and rapid acceleration, plus lower operating costs.
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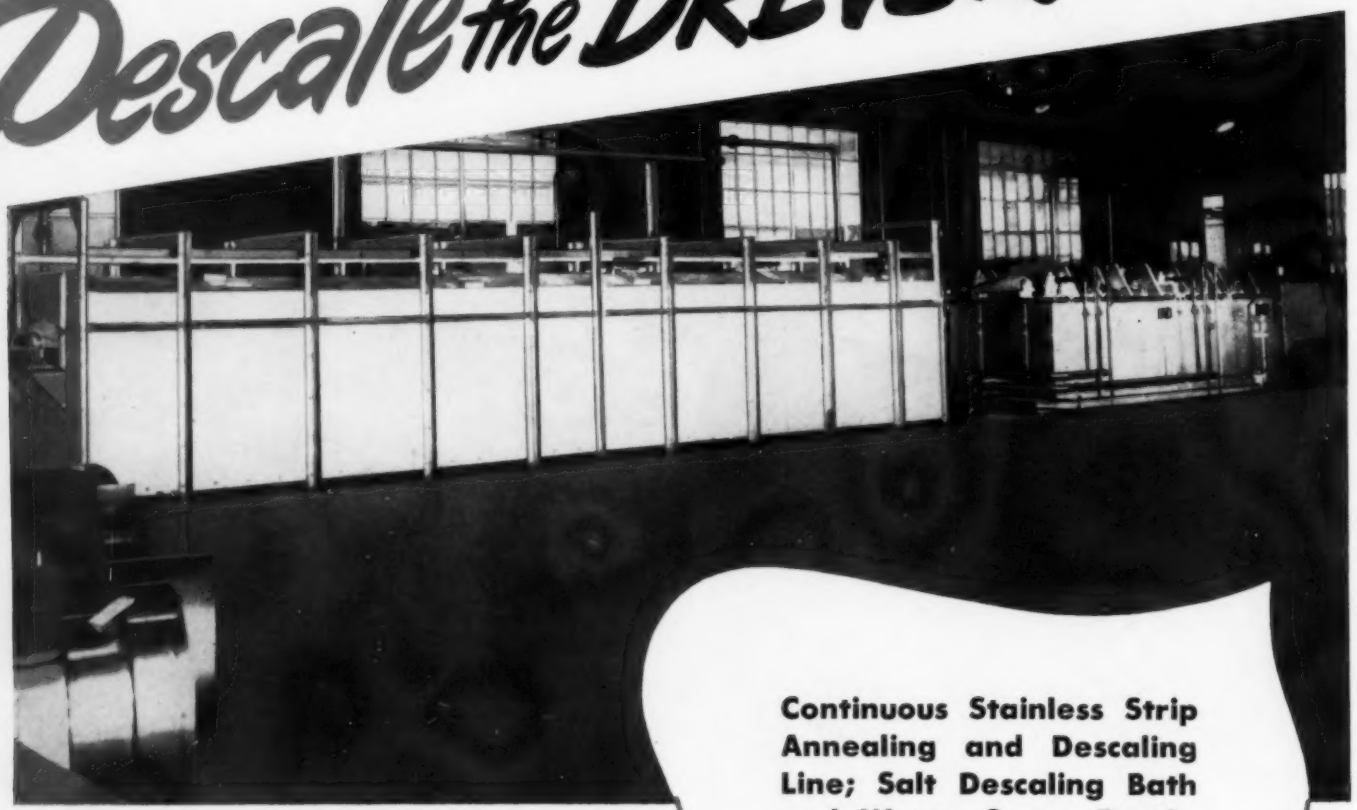
A plastic, acid-resistant steel tray coating, with high insulating qualities and the ability to withstand hard knocks.
NEW QUARTER TURN PLASTIC VENT PLUGS
Made of unbreakable polyethylene. Can be quickly and easily removed to add water.
HOMOGENEOUS SEALING COMPOUND
resists shock, without cracking, at high or low temperatures. Forms a permanent seal between jar and cover.
MOLDED SEAMLESS SHOCK-PROOF JAR
High quality rubber. Sturdy . . . built for a long life of heavy duty service.

Descale the DREVER way *



Continuous Stainless Strip Annealing and Descaling Line; Salt Descaling Bath and Water Spray Booth.

*without acid pickling

...either Continuously or by Batch Method

DREVER molten salt descaling furnaces rapidly and positively remove oxide scale and sludge without attacking the best metal. The salt bath is heated by immersion tubes, with automatic temperature control up to 950° F. More efficient than acid pickling, for both ferrous and non-ferrous metal... for strip, plate, wire or other products.

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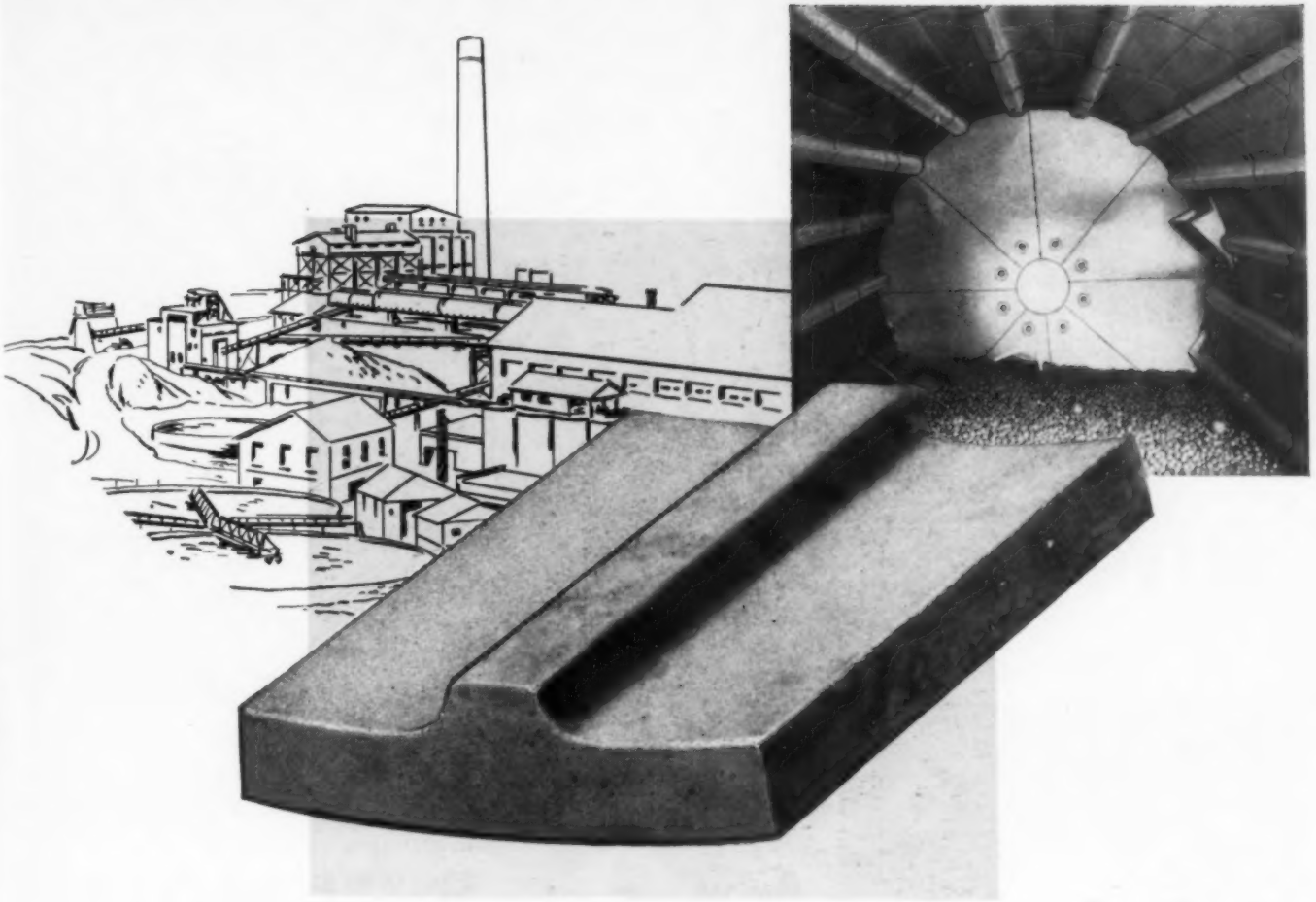


this LINER boosted production 35%

AMSCO Ball Mill Liners

Reduced Down-Time, Increased Production...

A large West Coast cement producer found that Ball Mill Liners were causing expensive trouble. Liners were thick—*over 3 inches.* This meant reduction in mill capacity. Thick liners also meant tremendous weight. Both thickness and weight reduced production and efficiency. *Liners wore rapidly,* too, causing frequent, expensive replacement jobs, with costly labor and material. And added to the bill was lost production due to mill down-time.

Well-known for their skill in handling impact and abrasion-resistant alloys, AMSCO engineers and foundrymen were consulted.

AMSCO solved the Ball Mill Liner problem.

AMSCO designed a new, light, thin—*1 inch thick*—liner, which because of lightness and thinness increased mill capacity, heightened efficiency. The new liners lasted beyond all expectations and in addition the segments were easier to install. These factors, plus reduced replacement down-time, have been responsible for a *35% increase in production.*

AMSCO is the largest producer of Manganese Steel, "the toughest steel known," which has proven itself under countless abrasion and impact situations. And where the service conditions require it, AMSCO also produces Chromium-Molybdenum and Chrome-Manganese alloys.

If you have a tough wear problem and suspect that there may be a better alloy for your purpose, you are invited to write to AMSCO for further information.

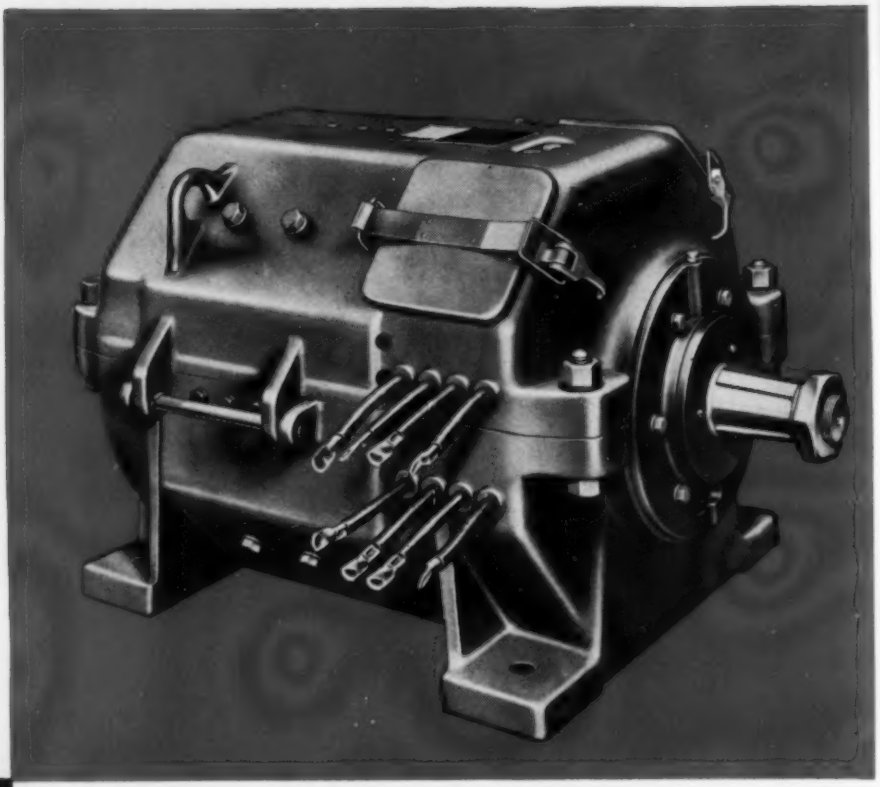
AMERICAN Brake Shoe COMPANY

AMERICAN MANGANESE STEEL DIVISION

411 EAST 14th STREET • CHICAGO HEIGHTS, ILL.

Other Plants: New Castle, Del., Denver, Oakland, Cal., Los Angeles, St. Louis. In Canada: Joliette Steel Division, Joliette, Que.
Amsco Welding Products distributed in Canada by Canadian Liquid Air Co., Ltd.

If it's a heavy duty drive...



WHERE TOUGHNESS COUNTS *is on jobs like this — one of four 200-hp Elliott Crocker-Wheeler Mill Motors driving the roll tables on a slabbing mill. These motors with their associated equipment are designed to accelerate the 24 rolls per table from standstill to rated speed in from 2 to 2.8 seconds. The unretouched photo graphically shows the conditions under which these motors operate.*

ELLIOTT *Crocker-Wheeler* 600 *Series* MILL MOTOR

Put it up against the toughest service in mill or crane — give it punishing overloads, constant stopping and starting, reversing strains, heat, dust, fumes, or any other grief. This is the motor that will take it and come up asking for more.

Adaptable, too. The standard 600 Series motor can be modified for use as a separately forced-ventilated type, and if required, as a protected self-ventilated type, also if required can be supplied with built-in back gear unit. In every case, servicing is fundamentally simple, for the cast-steel split frame can be opened to admit of free access to the interior.

For details, ask your local Elliott field engineer, or write for the Mill Motor Bulletin to Elliott Company, Jeannette, Pa.

ELLIOTT Company

CROCKER-WHEELER DIVISION

W3-3

By MELVIN NORD, Patent Attorney, Detroit, Michigan

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . . patents reviewed cover period December 23, 1952 through January 13, 1953 . . . .

CONTROL OF PRESSURE-DROP IN BLAST FURNACES

▲ In U.S. 2,625,386, by Otto J. Leone, assignor of one-half to David P. Leone, a method and apparatus are described for controlling and drop in gas pressure through the charge of stock in a blast furnace, in order to obtain a more uniform descent of stock in the furnace shaft and to control the counterflow of gases so as to avoid "slips" and "hanging" stock. The essential feature of the method is a differential-pressure controller, regulating a restrictive valve in the downcomer, in the blast main, or in a bleeder valve.

(Editor's note — *An article describing this method is published elsewhere in this issue.*)

MELTING OF STEEL SCRAP

In the production of steel in metallurgical furnaces such as the open hearth furnace, a relatively large quantity of cold ferrous metal scrap is charged into the furnace and then heated to melt the scrap. Charging such a large quantity of light solid scrap into the open hearth furnace requires considerable time, as does the heating and melting of the scrap. This in turn reduces the number of heats per furnace for a given period and reduces the number of tons of steel produced per day per furnace. The time required for heating scrap is increased when the scrap is relatively small or light. This type of scrap is cheaper, and it would be economical to use such scrap if the charging time could be greatly reduced. When oxygen is used to burn the fuel for heating open hearth furnaces, the problem of lost time in charging the scrap becomes more pronounced as the furnace requires more frequent charging, and the charging period takes a larger percentage of the time per heat.

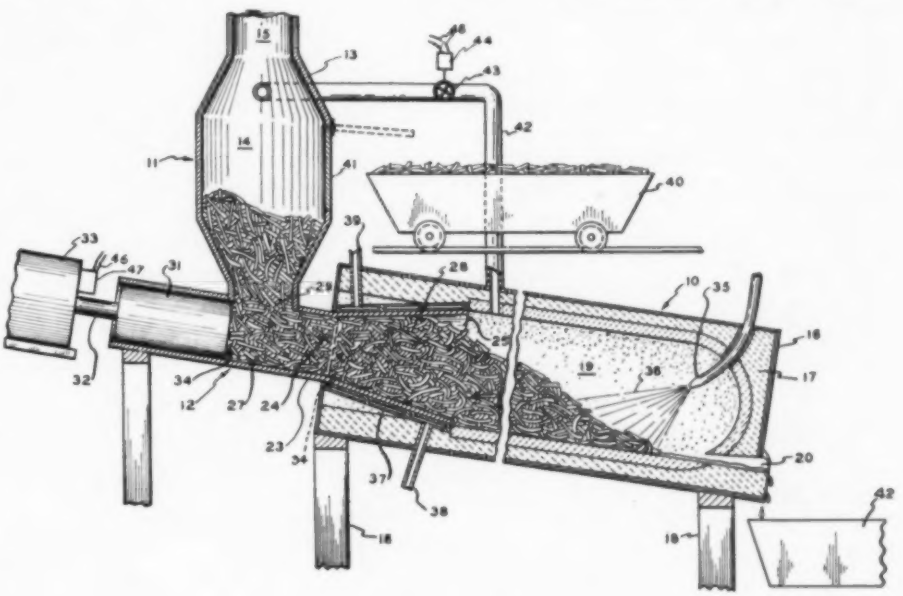


Figure 1

In U.S. 2,624,565, by Walter W. Kompart, assigned to National Steel Co., an apparatus for melting lightweight steel scrap is disclosed. The apparatus is shown in Figure 1. The furnace 10 is lined with refractory material 17, and is heated by means of burner 35. Scrap enters from a hopper 14, being pushed in by means of a reciprocating piston 31. Hot gaseous products of combustion pass through the scrap and out stack 15, preheating the scrap in the hopper. A water-cooled jacket 37 cools the feed passage. Scrap is charged by means of a buggy 40 through a door 41 in the side of the hopper. Molten metal leaves by gravity flow through outlet 20 into a receiver or ladle 42 which is used to transport the molten scrap metal to the open hearth furnace.

CHROMIUM STEELS WITH IMPROVED MECHANICAL PROPERTIES

A series of new corrosion-resistant chromium alloy steels of improved

mechanical properties are disclosed in four patents by the Union Carbide and Carbon Corp.

In U.S. 2,624,668, by William O. Binder, the composition of the steel is as follows: 20 to 30 per cent Cr, up to 0.035 per cent C, up to 0.08 per cent N, (C+N) > 0.06 per cent, 0.25 to 1.5 per cent Al, 0.5 to 3.5 per cent Ni, up to 3 per cent Cu, (Ni+Cu) > 4 per cent, up to 1 per cent Si, up to 3 per cent Mn, up to 3 per cent Mo, the remainder iron. In U.S. 2,624,669, by Walter Crafts, the composition is 20 to 30 per cent Cr, up to 0.03 per cent C, up to 0.08 per cent N, (C+N) > 0.06 per cent, 0.25 to 1.5 per cent Al, up to 1 per cent Si, up to 2 per cent Mn, up to 3 per cent Mo, the remainder iron. These aluminum-containing ferritic stainless steels have good mechanical properties and corrosion resistance after a simple annealing treatment.

In U.S. 2,624,670, by William O. Binder and Roger A. Perkins, the composition of the steel is as follows: 20 to 23 per cent Cr, 1 to 3 per cent Ni, 2.5 to 4.5 per cent Mn, (Ni+Mn) > 6 per cent, 0.2 to 1.0 per cent Cu, 0.2 to 0.8 per cent Mo, up to 1 per cent Si, 0.02 to 0.05 per cent C, 0.02 to 0.20 per cent N, (C+N) > 0.05 per cent, the remainder iron. This steel is hot-workable, resistant to corrosion in oxidizing or reducing acid conditions, has good impact strength at room temperature, and has decreased sensitivity to elevated temperatures and conditions of heat treatment. It has a high yield strength and high ductility, can be made by conventional melting practices, and requires smaller quantities of strategic alloying metals than the standard austenitic grades of stainless steel.

In U.S. 2,624,671, by William O. Binder and Russell Franks, the steel contains 20 to 40 per cent chromium, carbon and nitrogen in such proportions that their sum does not fall above the curve AB in Figure 2 and is preferably below the curve CD, the remainder being essentially iron. Unless the carbon and nitrogen are kept in the very low range indicated in Figure 2, high chromium ferritic steels are notch-sensitive at room temperature. To obtain such low carbon and nitrogen levels, it is necessary to carry out the melting and casting of the steel at a low pressure (less than 1000 microns), in contact with an oxygen-bearing material. Under these conditions, the carbon is oxidized in preference to the chromium and the CO is readily removed from the steel. The reduction in nitrogen content of the steel is due to the lowering of the partial pressure of nitrogen over the bath. Inert gas atmospheres (argon or helium) may be used in place of reduced pressure, if desired.

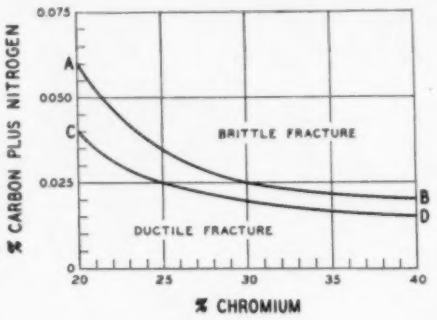


Figure 2

METHOD OF ALLOYING HIGH CARBON STEEL AND COPPER

High carbon steel can be successfully alloyed with copper by a method disclosed in U.S. 2,622,978, by Christopher H. Audette. Six parts of high carbon steel are placed in a crucible and heated to 2860 F, bringing the steel to the molten state. The temperature is then reduced to 2540 F. To this molten steel is added 10 parts of copper, 1¼ parts of blister copper, and 3 parts of copper sulfate. All of the ingredients are then agitated thoroughly with a carbon element, after which the alloy is poured. The purpose of the copper sulfate is said to be that of an oxidizing agent.

The alloy so obtained is claimed to be rustproof and to have greater toughness than high carbon steel or copper.

METHOD OF SURFACE HARDENING STEELS

Steels of compositions such as 0.30 to 0.35 per cent C, 0.70 to 1.00 per cent Mn and 0.90 to 1.20 per cent Cr have been considered to be unsuitable for surface hardening by quenching, since water cooling is liable to cause hardening cracks and air cooling fails to produce the required hardness. In U.S. 2,623,836, by Tore Mans Ivan Noren, assigned to Elektriska Svetsningaktiebolaget, a method is disclosed for avoiding these difficulties. The method involves cooling first with a current of air for about 10 seconds, down to 400 to 500 C, followed by water quenching. With the type of steel referred to, the air quench is rapid enough to avoid the formation of pearlite, but not rapid enough to prevent the formation of bainite. The water quench is used to produce martensite instead of bainite. By using this double quenching method, the desired martensitic structure is obtained without the risk of crack formation caused by the use of conventional water quenching.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Subject to Patent	Inventor or Assignee
2,622,304	Molybdenum silicate refractory	Climax Molybdenum Co.
2,622,440	Pressure gage for forging presses	The National Machinery Co.
2,622,720	Roller conveyor	United States Steel Corp.
2,622,861	Rotary hearth furnace for heating steel billets	Randal E. Talley
2,622,870	Sintering machine	Sintering Machinery Corp.
2,622,875	Pivoted automatic pinch roll arrangement for continuous electrolytic tinning or pickling lines	United States Steel Corp.
2,622,876	Apparatus for piling metallic sheets	United States Steel Corp.
2,622,977	Desulfurization of pig iron with lime in a continuous rotating furnace	Michael S. Kalling, Pehr A. Christer, and Ottar J. L. Dragge
2,623,846	Coke oven with regenerator flow control	Koppers Co., Inc.
2,623,849	Neutralization of spent pickle liquor	Harry L. Peterson
2,624,178	Cooling of metal rods in hot-rolling mills	Blaw-Knox Co.
2,624,560	Shaft furnace for heating pellets of iron ore concentrates	Arthur G. McKee & Co.
2,624,561	Heat-treating furnace	Surface Combustion Corp.
2,624,667	Cartridge for below-surface treatment of molten metals	Julius S. W. Bates
2,624,687	Heat-treating alloy steel	Bower Roller Bearing Co.
2,624,688	Subzero treatment of chromium alloy steel	Odin Corp.
2,625,387	Furnace for rapid heating of sheets or billets for annealing or normalizing	Selas Corp. of America

$15 is too much when you can get it for $98.50!

Forget first cost . . . find out how much longer *better* replacement parts last, how much down-time they save! STOODY ALLOY CASTINGS, like the guide roll above, may be a bargain at several times the price of ordinary parts because of the uninterrupted production they insure.

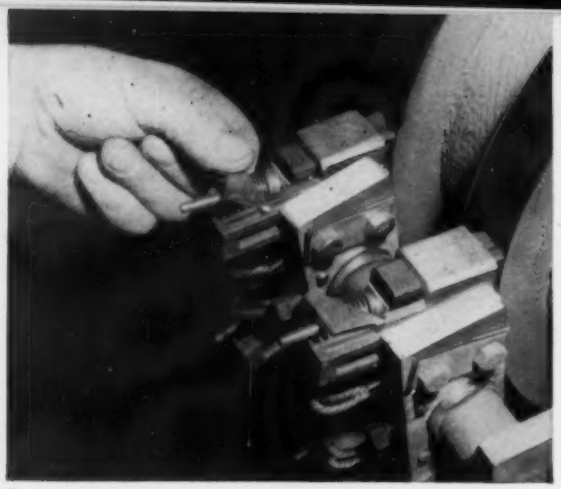
Manganese, chilled iron or tool steel guide rolls produced not over 3000 tons each. On the same job this Stoody Alloy Casting delivered 30,000 tons, or 10 times the production! Besides increasing tonnage downtime was avoided.

A request on your letterhead will bring the booklet "Stoody Castings." Please include an outline of your operations involving castings.

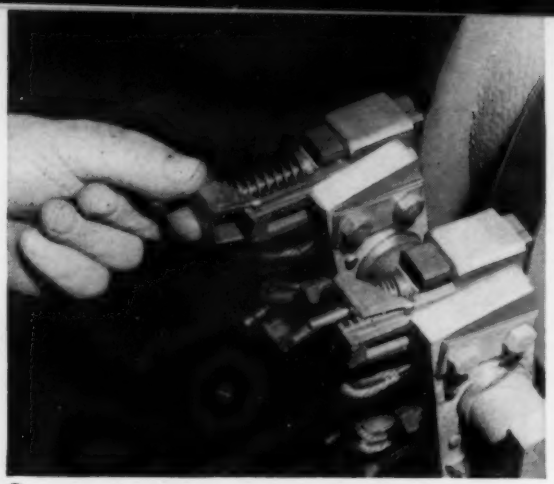
If you have unusual wear, corrosion and heat problems in your operations, STOODY CASTINGS machined to precise tolerances may be the answer. We'll be glad to give you the benefit of our experience in the production of such parts as steel mill guides, bushings and bearings, forming rolls, and the like.

STOODY COMPANY

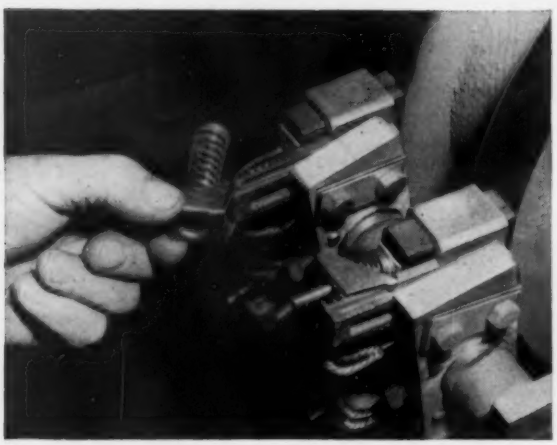
11942 EAST SLAUSON AVENUE, WHITTIER, CALIF.



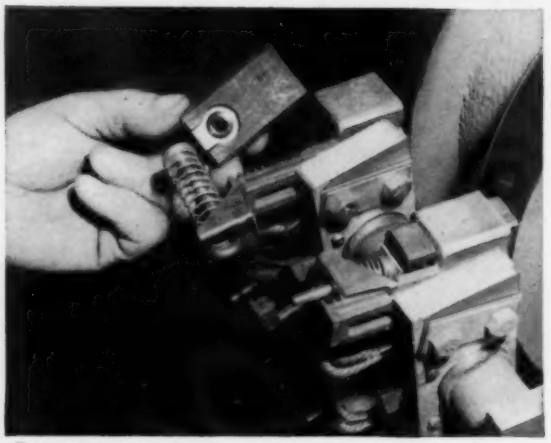
1 To reset brush tension, operator releases spring lock . . .



2 slides it back to relieve pressure . . .



3 and swings locking device to one side . . .

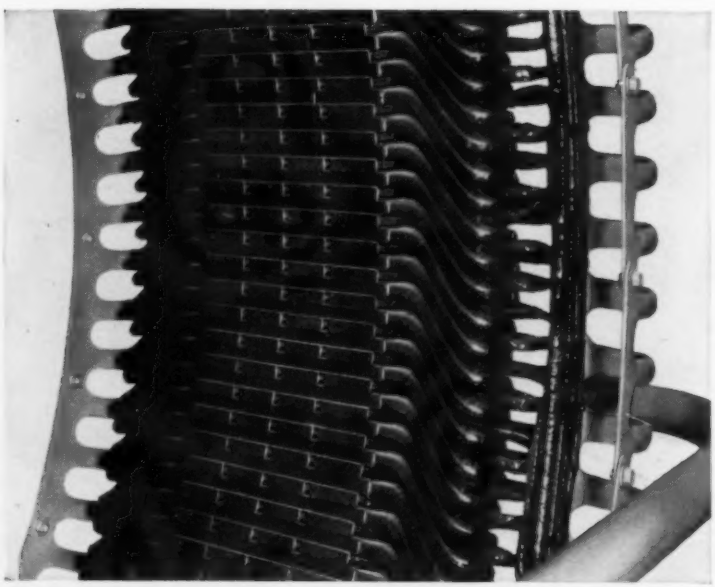


4 for fast and easy brush removal.

BRUSH-PRESSURE ADJUSTMENT, for maximum brush life, and replacement, to assure reliable motor service, are simple matters on G-E synchronous motors. A calibrated spring-loaded brush holder makes resetting brush tension or removal of brushes fast and easy. Brushes are staggered for even brush-ring wear.

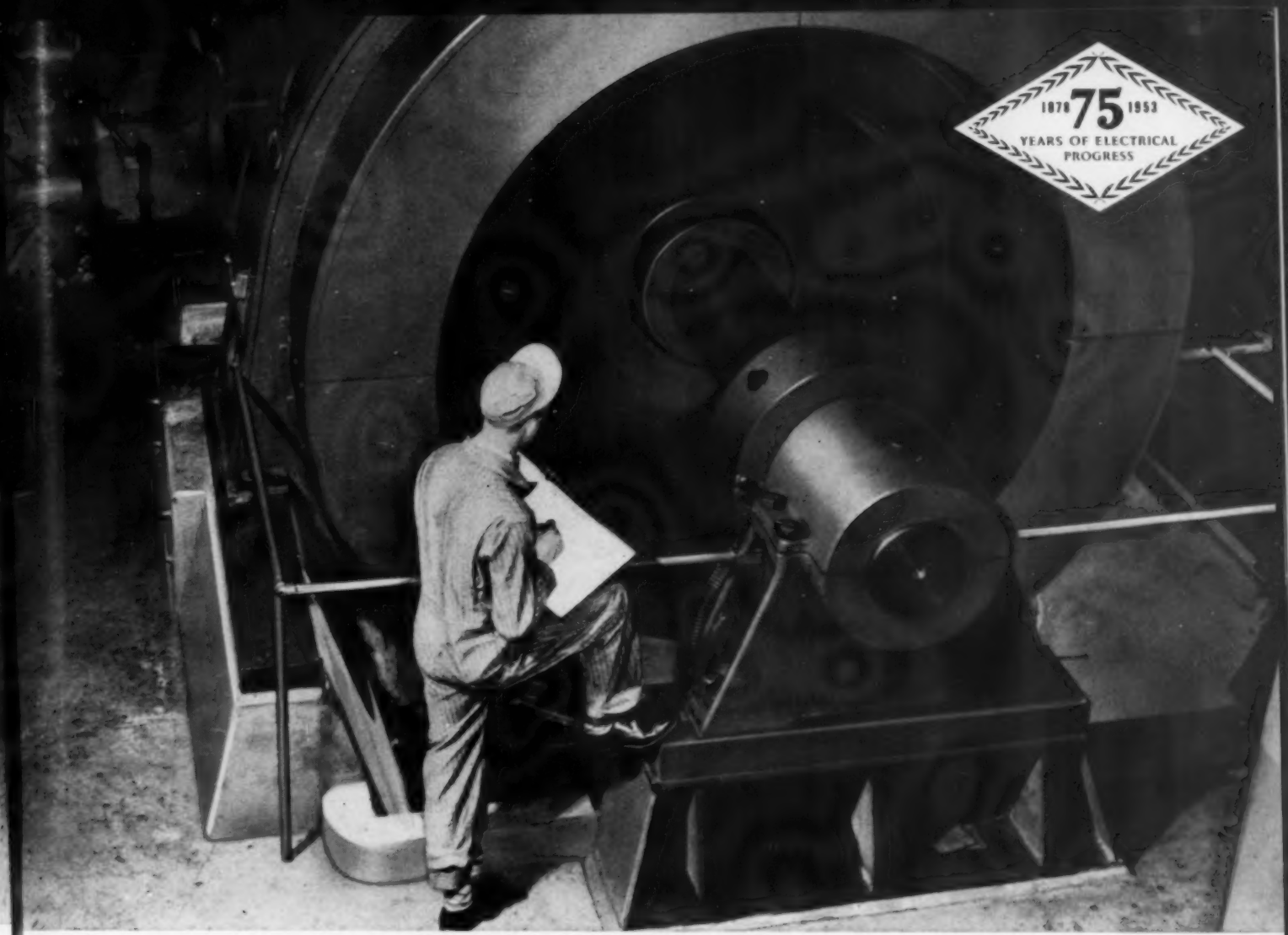
See How Routine Maintenance Is

BEARING LUBRICATION can be readily checked through a large sight-level gage on the bearing pedestal; and when oil is required, handy snap-top covers are provided for easy refilling, as well as oil-ring inspection. A drain plug is conveniently located for quick oil changes.



INSULATION CLEANING is fast on G-E synchronous motors. Windings are coated with a high-gloss Glyptal* varnish that resists the accumulation of dust and can be vacuum or air cleaned in most applications. In extremely dusty or oily atmospheres, deposits can be easily wiped from the windings. Clean windings mean longer insulation and machine life.

*Reg. trademark of General Electric Co.



THIS G-E SYNCHRONOUS MOTOR, RATED 4500 HP, 300 RPM, DRIVES A RECIPROCATING GAS COMPRESSOR.

Easier on G-E Synchronous Motors!

Routine maintenance involves three factors: brushes, lubrication, and insulation. To be sure that these areas are properly serviced, G-E synchronous motors have design features that make checking easy and maintenance fast. Close at hand and easy to adjust, the brush-rigging construction encourages your maintenance men to inspect regularly. Oil-level gage and inspection caps are arranged for quick checking and filling when necessary. The high-gloss insulation on G-E synchronous motor windings resists the adhesion of dust and minimizes the need for cleaning.

These features promote long, reliable motor service and save valuable time for your maintenance crews.

Before selecting your next heavy-duty motor, be sure to consider these important maintenance features. Call in your G-E representative. He will be glad to discuss the many money-saving applications for G-E synchronous motors. Meanwhile, you can obtain more information on G-E synchronous motors by requesting the following publications: GEA-5332, "Low-speed Synchronous Motors" or GEA-5426, "High-speed Synchronous Motors." Write to Section 770-28, General Electric Company, Schenectady 5, N. Y.

You can put your confidence in—

GENERAL ELECTRIC

A HE-MAN CRANE FOR A HE-MAN SHOP!

One machine tool primer defines a forge shop as "a place for a real he-man who can stand up and take it."

That overhead electric traveling crane—which must always be ready and able—must also have he-man ruggedness and dependability

Moving swiftly back and forth—from furnace to forging press—this 25-ton NORTHERN CRANE swings hot billets, too hot and too heavy to handle in any other way.

This is one of the many NORTHERN CRANES installed in the last 54 years to assure the most efficient production from machine tools and other machinery.

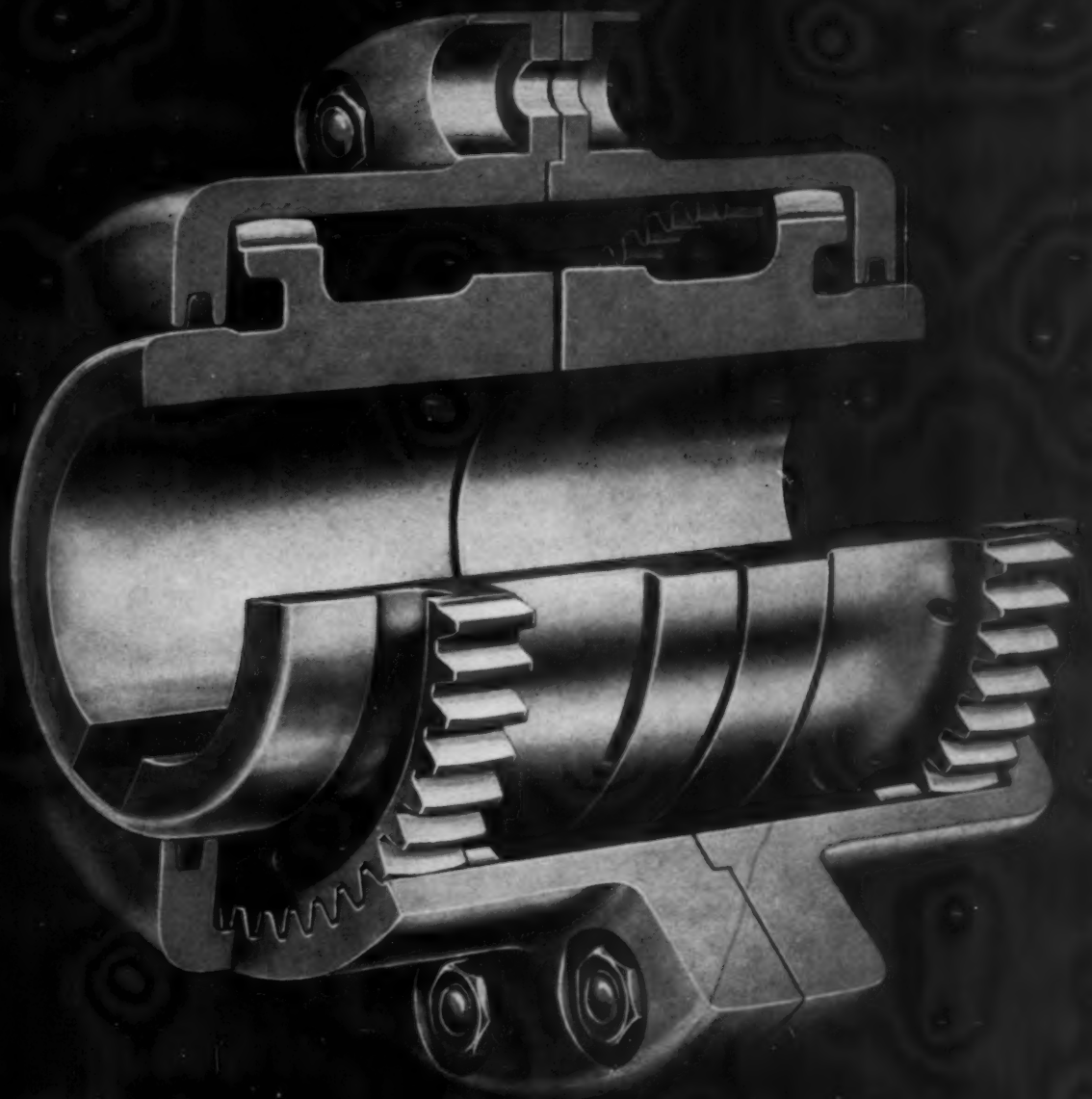
USE NORTHERN CRANES

NORTHERN ENGINEERING WORKS

2615 ATWATER STREET, DETROIT 7, MICHIGAN

BUILDERS OF CRANES AND HOISTS EXCLUSIVELY

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

Where Quality Counts Most . . . Count on

NATIONAL CARBON BRUSHES

TRADE-MARK

FOR MAIN-DRIVE MOTORS AND GENERATORS

Quality *counts* most where failure *costs* most . . . in the main drives and generators upon whose sustained efficiency uninterrupted production depends.

Chances are you're already *paying* for the best brushes in these and other vital applications; make sure you *get* the best by specifying "National" brushes.

For toe-to-toe and tandem-type holders, there are "National" STANDARDIZED brushes to meet your requirements . . . delivering not only the uniform high quality and dependability of *all* "National" brushes, but the added conveniences of uniform packaging, delivery from stock and the big economy of a *flat unit price!*

HERE'S WHY "NATIONAL" BRUSHES ARE BETTER:

- Service proved dependability
- Closely controlled commutation factor
- Minimum commutator wear
- Long life
- Uniformity from shipment to shipment

NATIONAL STANDARDIZED BRUSHES

BETTER— PRODUCT—PACKAGE—PRICE— FASTER

The term "National", the Three Pyramids device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices:
Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

In Canada:
NATIONAL CARBON LIMITED
Montreal, Toronto, Winnipeg

over ELEVEN MILLION TONS

TSP screwdown screws set world's record at Inland Steel Co!

These screws on their 46" Blooming Mill are still in operation!

HERE'S WHY: "Tool Steel Process" screwdown screws are made of low carbon alloy steel. File hard wearing surfaces are backed by a tough ductile core, resulting in super resistance to wear and fatigue.

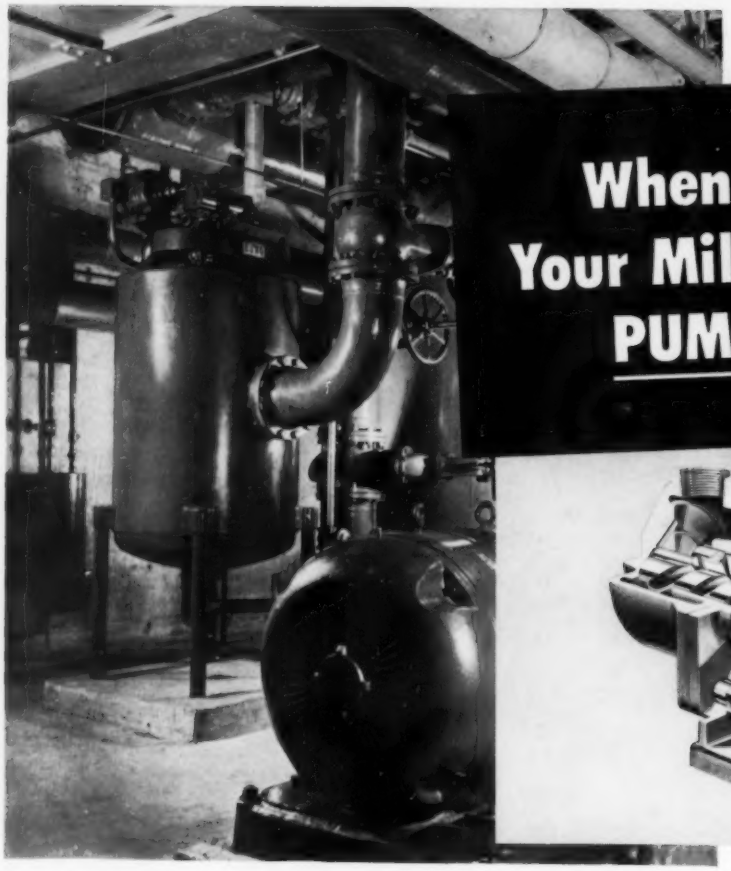
You receive an absolutely positive GUARANTEE that TSP Products will give a longer life in the same service than any other product.

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO, U. S. A.

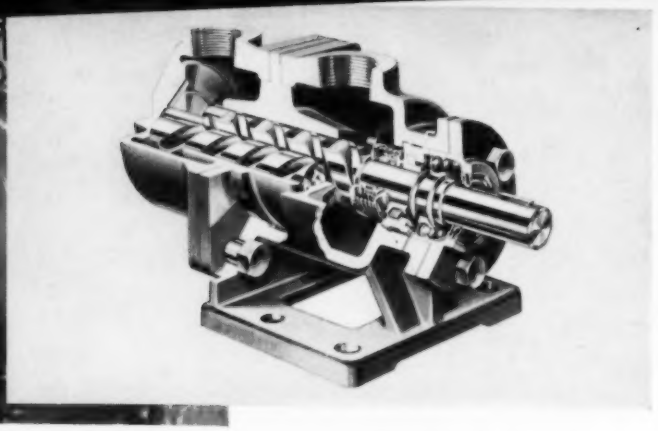
Specify "Tool Steel Process" Products today!
Write for Bulletin 652.

Ad No. 41

THE STANDARD OF QUALITY SINCE 1909 FOR GEARS, PINIONS, ROLLS, WHEELS, OTHER HARDENED PRODUCTS



When De Laval Designs Your Mill Lubrication System PUMPS Are Important



ALL DE LAVAL ENGINEERED MILL LUBRICATION SYSTEMS HAVE THESE SPECIFIC FEATURES

1. Proper Selection of Pipe Size
2. Correct Metering of Lubricant
3. Efficient Temperature Control
4. Purification of Lubricating Oil

For Large Mills:
Custom-built Lubrication System

For Capacities up to 50 gpm:
The self-contained Unilube
Single . . Simplex . . Double . . Dual

No piece of auxiliary equipment used in a custom-designed De Laval mill lubrication system is more important than the pump, because a constant streamline flow of the correct quantity of lubricant at the correct pressure must be maintained at all times. There are many pumps on the market that fulfill all mechanical requirements and that will work with complete satisfaction on these De Laval custom-built systems. Among the best is the De Laval-IMO, a product of the De Laval Steam Turbine Company.

Full axial flow guarantees pulsation-free delivery, thereby making De Laval-IMO pumps especially adaptable to systems where long pipelines are unavoidable. A third feature that makes them valuable on mill lubrication service is the lack of pilot gears, sliding vanes or reciprocating parts.

The study given by De Laval engineers to the selection of the right pump for each job is typical of the care given to engineering *every* detail precisely.

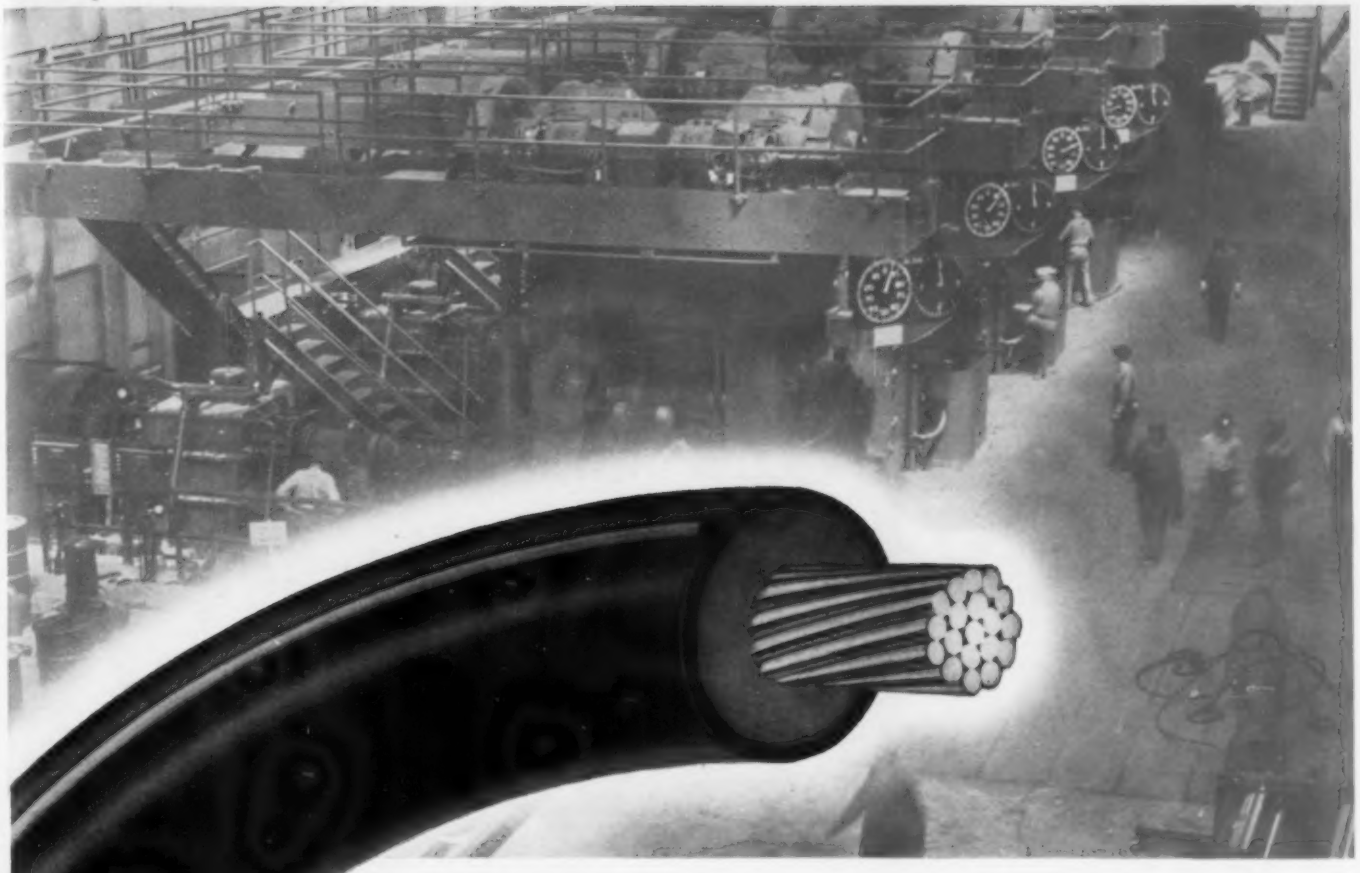
● ***Write for Bulletin 500.***

THE DE LAVAL SEPARATOR COMPANY
Chicago POUGHKEEPSIE, N.Y. San Francisco

●

DE LAVAL SALES & SERVICE, INC.
447 Fourth Ave., Pittsburgh 19

DE LAVAL *ENGINEERED SYSTEMS*



CUT OUTAGE TIME ALL ALONG THE LINE

with OKOLITE-OKOPRENE electrical cables

Steel mill conditions are rough on electrical cables. Heat, flame, moisture, dirt, mechanical damage, corrosive fumes—the life of an electrical cable is a continual fight against such elements. Electrical men in the steel industry reduce outages due to such conditions with Okolite-Okoprene cables.

Okolite-Okoprene is particularly suitable for use in steel mills because of the exceptional properties of its electrical insulation and protective sheath.

Okolite insulation, itself resistant to heat and moisture, is highly reliable under the continuous heavy usage characteristic of steel mills. Okolite has proved itself by a long record of trouble-free operation under severe service conditions.

Okoprene protective sheath is compounded from an exclusive Okonite formulation, the basis of which is neoprene. It contains no rubber. When exposed to most acids, alkalies, chemicals, oils and moisture, it will outperform any other common type of cable covering such as lead or braid.

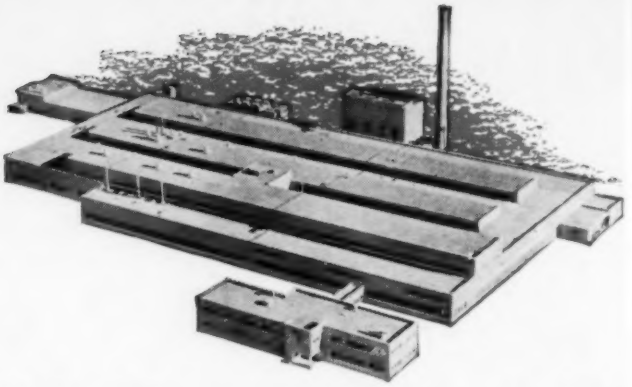
Okonite's famous strip process, for applying insulation and sheath simultaneously, adds still greater endurance to the cable. Conductors are perfectly centered, and both sheath and insulation are uniformly vulcanized to give higher mechanical and electrical properties of lasting quality.

Bulletin IS-1053 gives convincing facts on the stability and performance of Okolite-Okoprene. Write for it today to The Okonite Company, Passaic, N. J.

The best cable is your best policy

OKONITE SINCE 1878 *insulated wires and cables*

9804



N-B-M Meadville . . . where the welcome mat is out. We're proud of this plant—its equipment and the skilled people who work in it. Proud enough, in fact, to offer a standing invitation to Blast Furnace Superintendents or other steel mill officials to visit us. When can *you* make an inspection trip?

These Bosh Plates take it standing up

Here's where you'll find *vertical* molding of copper castings . . . resulting in cleaner metal throughout.

Another reason why N-B-M Meadville is a name to remember when you specify copper castings. During 75 years of foundry experience, you learn many answers to better methods of production . . . methods that *improve casting quality and soundness.*

At N-B-M Meadville, one of these quality-improving production methods is *vertical molding*—eliminating chaplets. We've found—both by test and on-the-job experience—that vertical molding means uniformly higher quality. Any N-B-M Representative will welcome the chance to describe this unique method to you.

From the molding floor to the shipping room, N-B-M Meadville accomplishes what should be, and is, the main objective of this modern, well-manned plant . . . ***what you specify . . . we ship.***

AMERICAN **Brake Shoe** COMPANY

NATIONAL BEARING DIVISION

4936 Manchester Avenue • St. Louis 10, Mo.

PLANTS IN: ST. LOUIS, MO • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

New, FORD Foundry Speeds Handling of—

SAND, PIG IRON, SCRAP, SLUDGE

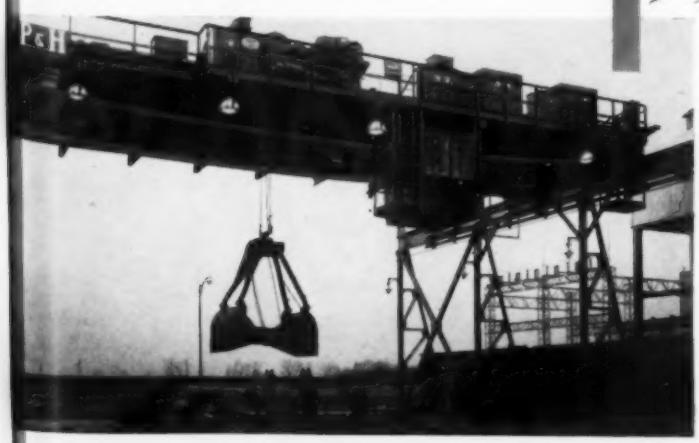
with

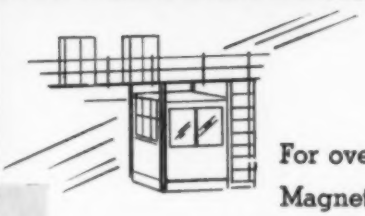
EC&M MAGNETS and EC&M CRANE CONTROL

THESE CRANES AT THE NEW, MODERN FORD FOUNDRY IN CLEVELAND ARE EQUIPPED FOR —

1. *Speed Control* with EC&M Cam Type Master Switches—Bulletin 1190.
2. *Smooth Starts and Stops* by EC&M Frequency Relay Controllers—Bulletin 930.
3. *Long-life Brake Operation* through EC&M Type WB Brakes —Bulletin 1006.
4. *Safety* with EC&M Manual-Magnetic Disconnect Switch—Bulletin 1024.

Also on the magnet cranes, EC&M Bulletin 900 ALL-WELDED Lifting Magnets and EC&M Bulletin 905 Automatic-Discharge Controllers speed scrap and pig iron handling at low cost.





For overhead foundry cranes, EC&M Magnets and EC&M Crane Control have earned a reputation for fast, safe handling of materials in all stages of production. Designed for highly repetitive operation, EC&M equipment gives "main-line, non-stop" service which, users know, results in quicker handling and lower cost per operation. When buying cranes, make it a point to specify EC&M Control and EC&M Magnets.

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • CLEVELAND 4, OHIO

Engineers and constructors

SWINDELL

..DRESSLER

...in the production of STEEL

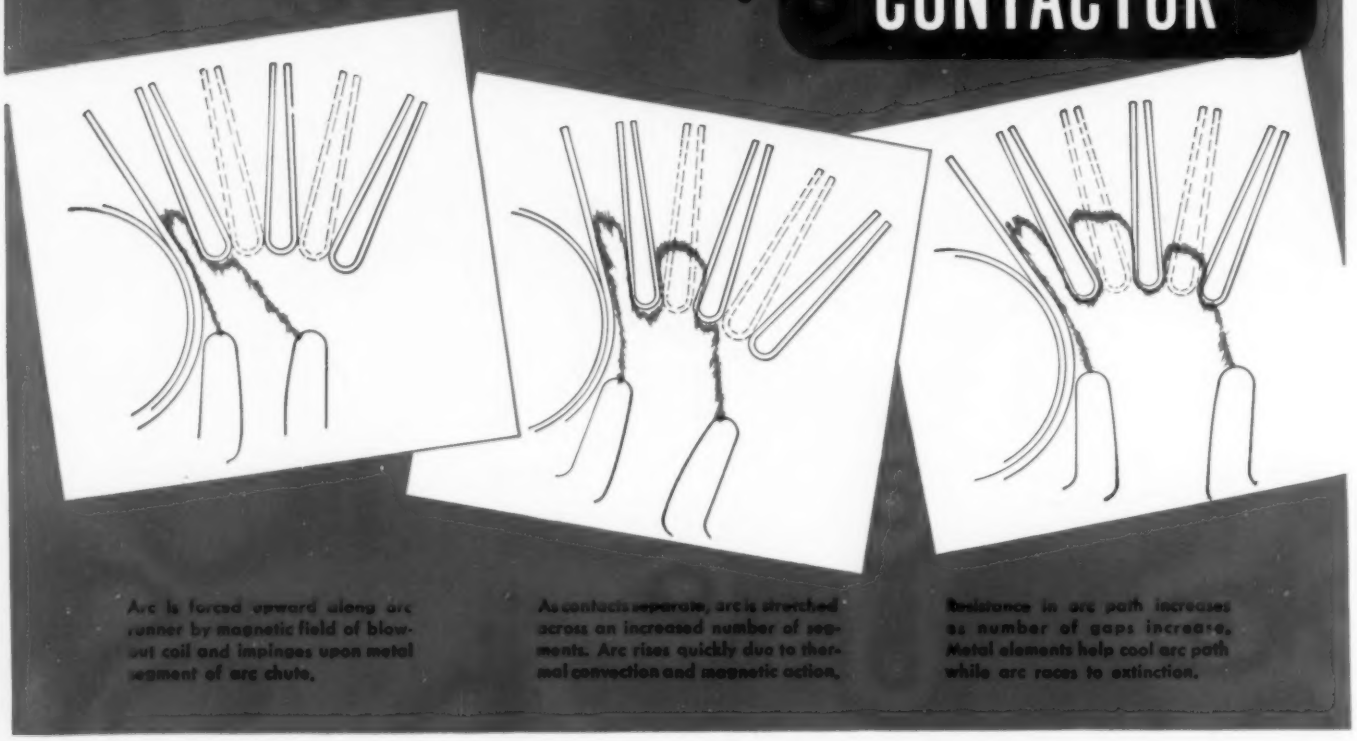
The engineering of steel-making facilities "from the ground up" is a major activity of Swindell-Dressler. • Whether the task is the construction of buildings and furnaces for a new electric melting shop (at left), or the engineering and management supervision of a gigantic open-hearth development in all its ramifications, Swindell-Dressler has the resources, the capacity and the experience for the job. • Let us discuss your coming requirements.

SWINDELL-DRESSLER *Corporation*

PITTSBURGH 30, PENNA.

trace the arc...

ALLIS-CHALMERS Mill Type 260 DC CONTACTOR

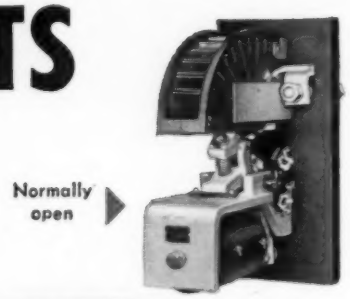


Arc is forced upward along arc runner by magnetic field of blowout coil and impinges upon metal segment of arc chute.

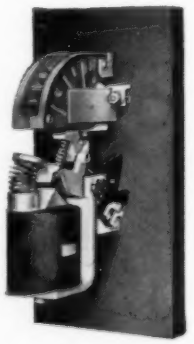
As contacts separate, arc is stretched across an increased number of segments. Arc rises quickly due to thermal convection and magnetic action.

Resistance in arc path increases as number of gaps increase. Metal elements help cool arc path while arc races to extinction.

QUICK QUENCHING CUTS CONTACT BURNING



Normally open



Normally closed

IN THE TYPE 260 heavy duty mill contactor, destructive burning and pitting of contacts is minimized by a new quick-quenching arc centering blowout. U-shaped metal segments mounted alternately in the arc chute act as individual blowout coils. As the arc strikes the loop of each segment, a magnetic field is established which forces the arc upward and toward the center of the chute.

Both thermal convection and magnetic action stretch, cut and cool the arc. Because the arc is extinguished in a cycle or less (on a 60-cycle basis) and is centered in the chute, contact life is greatly extended. Call your nearby Allis-Chalmers District Office or write Allis-Chalmers, Milwaukee 1, Wis. Ask for Bulletin 14B6505A.

A-4017

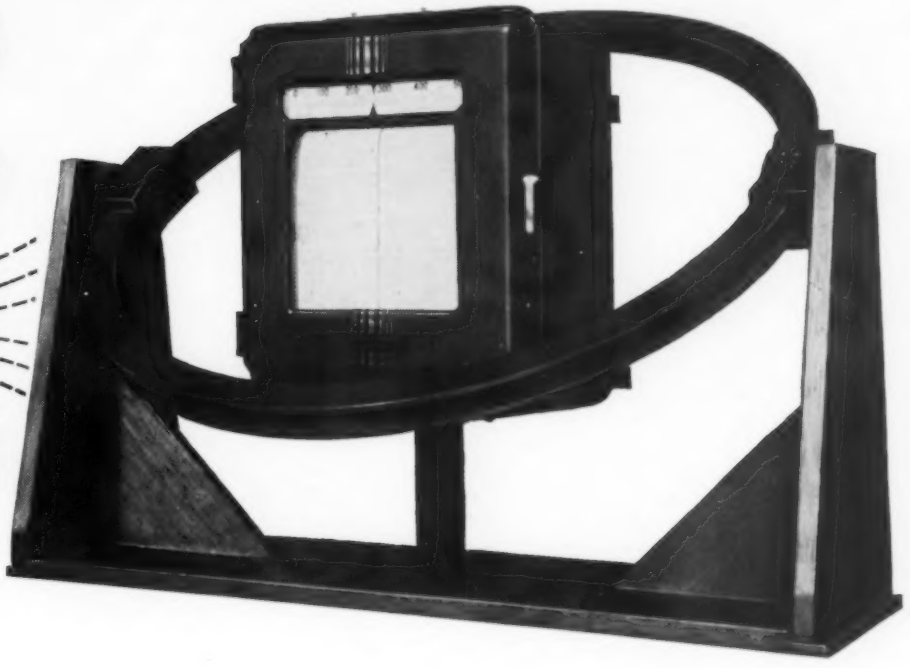
THREE RATINGS IN BOTH TYPES

Type 260 dc contactors cover virtually every steel mill auxiliary need. Both normally open and normally closed types are rated 150, 300 and 600 amp at 600 volts maximum.

ALLIS-CHALMERS

Here's how L&N engineers verify Speedomax resistance to stray electrical fields. The ring is a Helmholtz coil, adjustable for a wide variety of field effects.

Speedomax is engineered for FIELD service



● Built into every Speedomax recorder and controller is a high degree of indifference to stray electrical fields. And this is one of its most useful characteristics in almost any job. It means that you can install a Speedomax near a big motor, power line or X-Ray machine—any electrical equipment in fact—and you'll probably see no effect at all from surrounding electronic noise and "junk".

The reason for this indifference to stray fields goes back through the adjustment, building and design of the instrument, to its basic engineering. Speedomax has an *electronically-clean measuring circuit*, as well as clean signal and amplifier circuits.

This clean design includes a bifilar-effect slidewire, to eliminate any objectionable inductance at that point. It includes our "no-moving parts" trolley contact on the slidewire, which eliminates pigtails and their variable inductances. It includes use of a Mumetal slidewire shield where desirable, instead of less expensive but lower-permeability aluminum. And it includes a lot of just downright meticulous detailing, such as carefully engineered wiring and input filtering, plus ingenious shielding where required.

These and other precautions eliminate out-of-phase components in the supply to the amplifier. The latter therefore doesn't "load"; hence sends the correct amount of correct-phase power to the balancing motor. With ample power, the motor's recording and control action is snappy and accurate.

Our Catalog ND46(1) and Technical Publication ND46(1) tell the story. Write our nearest office or 4942 Stenton Avenue, Philadelphia 44, Pa.

Industry's engineers find that Speedomax instrument performance is not affected by the stray fields created by motors, electric furnaces, magnets, power lines and so on.

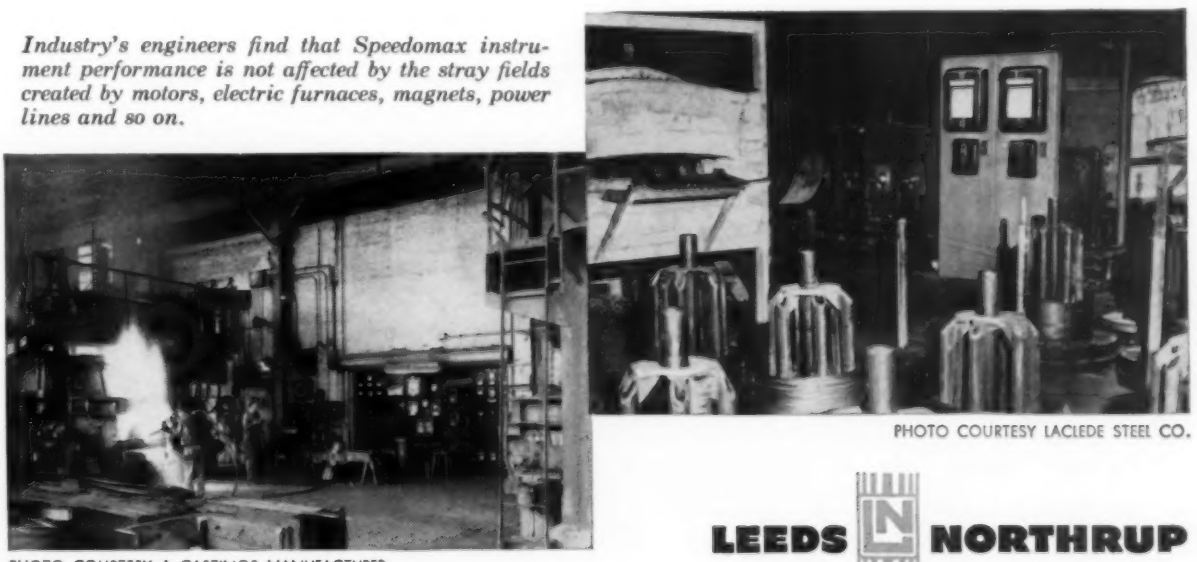


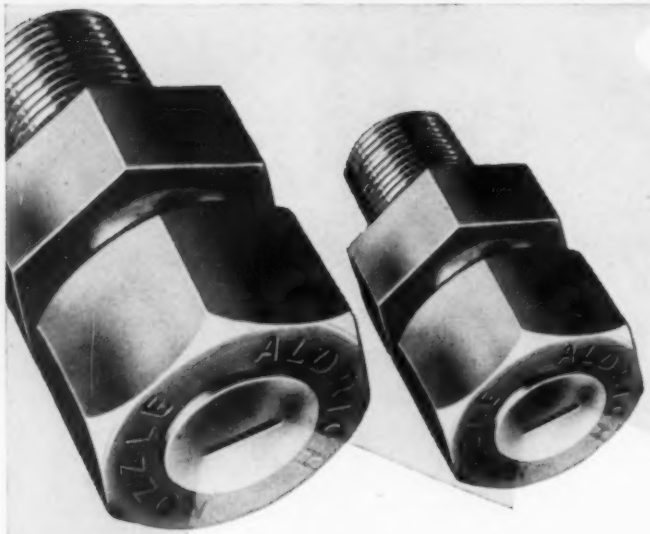
PHOTO COURTESY LACLEDE STEEL CO.

PHOTO COURTESY A CASTINGS MANUFACTURER

Jrl Ad ND46(10)

LEEDS NORTHRUP

instruments automatic controls • furnaces



Why ALDRICH Nozzles Give You EFFECTIVE DESCALING

1. The sharp, knife-like jet of water and the solid striking force developed by Aldrich Patented Descaling Nozzles give far more effective descaling than nozzles which produce jets of equal force but with a larger impinging area. This has been proved in hot strip as well as billet descaling.

2. By use of Venturi tube design and a rectangular orifice, Aldrich Nozzles produce a cutting spray with an impinging force equal to 95% of the potential energy supplied to the orifice—resulting in thorough descaling without causing excessive cooling due to over-abundant use of water.

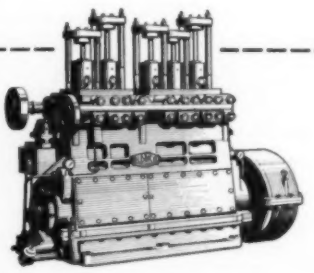
3. Should clogging occur, Aldrich design permits easy cleaning of the orifice disc. When replacement becomes necessary, you need only insert a new disc—NOT AN ENTIRE NEW NOZZLE.

4. Aldrich orifice discs have a ½" bevel on the inside circle—preventing too sudden choking of water when it reaches the disc—also preventing undue wear and friction loss.

5. Aldrich discs are capable of withstanding high pressures for long periods of time. They are made of hardened stainless steel, machine ground to uniform contour, then profiled and burnished to a polished finish. This removes the slightest imperfection on the orifice—preventing streaking on the surface of metal being descaled. Every Aldrich disc is hydraulically tested for uniform pattern and force.

6. Whether used for hydraulic descaling of billets, sheets, plates, or small parts—Aldrich Nozzles insure rapid and thorough descaling; prevent excessive cooling; increase roll and pass life; reduce damage to forging dies; reduce delays due to grinding or changing guides, and afford longer service per insert disc.

Several types of Aldrich Descaling Nozzles are available from stock. May we send you complete information? Data Sheet 61-2 is available on request.



Aldrich Direct Flow Pumps used for descaling systems are fitted with automatic by-pass valves which operate with all types of accumulators. Both descaling cabinets and hydraulic systems, for shell forgings and other small to medium forgings, have been designed by Aldrich. Write for literature or recommendations.

THE ALDRICH PUMP COMPANY

21 PINE STREET • ALLENTOWN, PENNSYLVANIA

...Originators of the Direct Flow Pump

Representatives: Birmingham • Bolivar, N. Y. • Boston • Buffalo • Chicago • Cincinnati • Cleveland • Denver • Detroit
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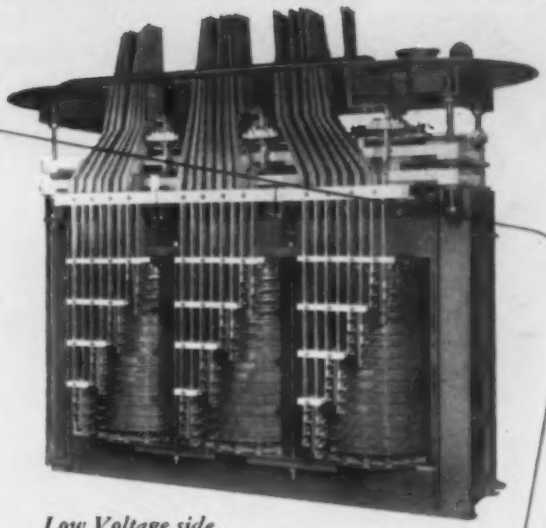
How Pennsylvania solves 3 major Furnace Transformer Problems



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The complicated design of a furnace transformer presents many problems that do not apply to other types of transformers. Many special conditions such as overloads, short circuit stresses, distribution of currents and reduction of eddy losses must be met by engineering skill and highly perfected workmanship. Here is how Pennsylvania Transformer Company solves three of these major problems:

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2. **BALANCING OF STRESSES** Pennsylvania coils are balanced to reduce the radial and axial short circuit stresses to a minimum. 1. The circular shape protects the coils against deformation due to radial short circuit forces. 2. The total axial short circuit force is calculated for each design and the coils are subjected to an equivalent pressure in an hydraulic press. The ability of the coils to maintain their shape, under the prescribed pressure, guarantees that the transformer will safely withstand short circuits.

3. **DISTRIBUTION OF CURRENTS** Due to the heavy secondary currents, the winding must be subdivided into numerous parallel sections. A unique arrangement of the windings insures that each section carries an equal share of the current.

Careful transposition of the individual conductors of each section in the windings reduces the copper eddy losses to a minimum. This results in improved efficiency, more uniform copper temperature and prevention of hot spots.

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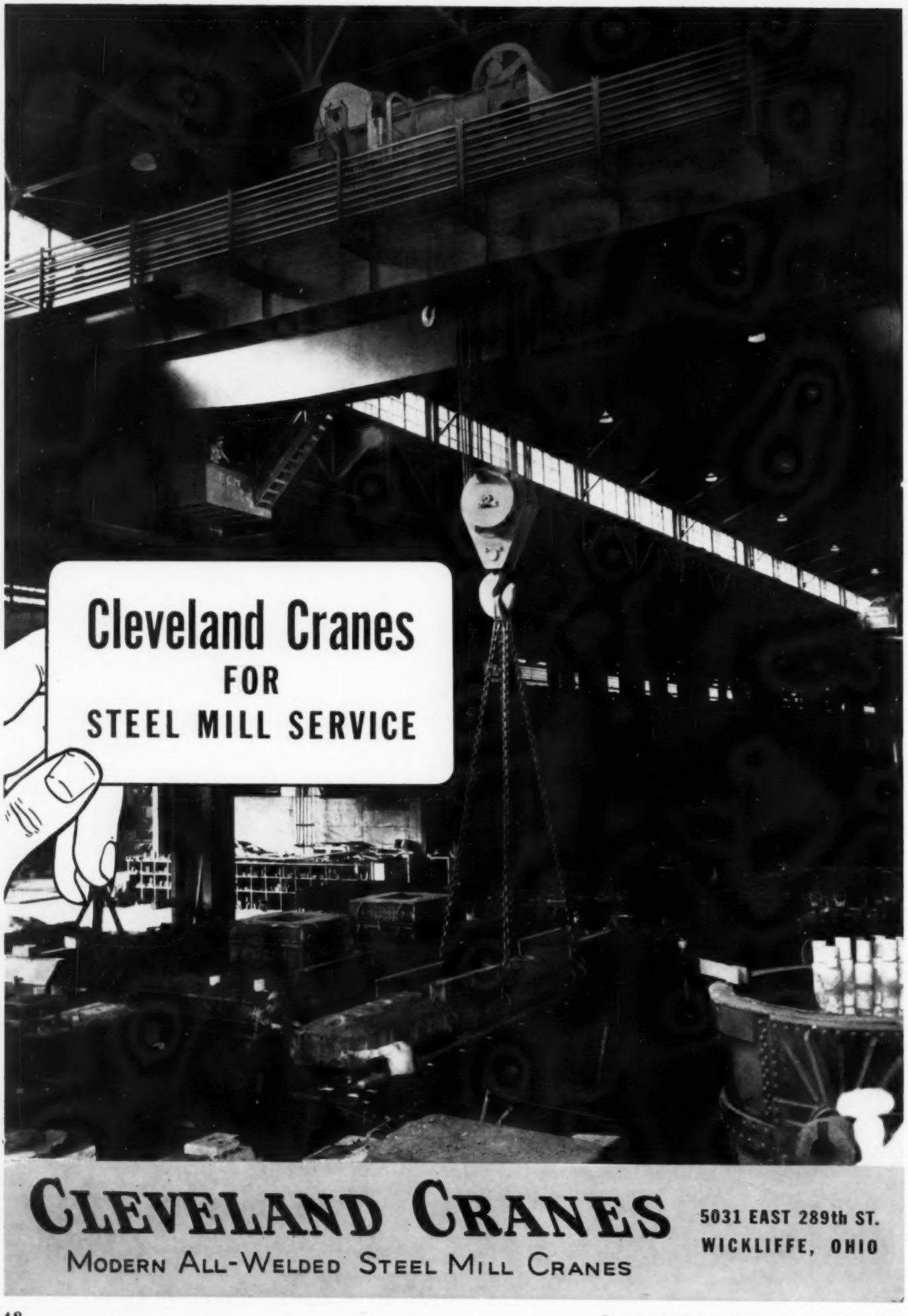

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Crops *and* Shorts

THE Cleveland Technical Societies Council is sponsoring a series of TV programs aimed at interesting high school students in engineering as a career. Each weekly show is staged by one of the 40 societies affiliated with the council. The program for March 1 was put on by AISE, and was called "The Unglamorous Gals," a title which, our correspondent hastens to inform us, referred solely to blast furnaces. The Association was represented by I. N. Tull of Republic Steel Corp., F. E. Robinson of American Steel and Wire Division, United States Steel Corp., and F. J. Baier of Arthur G. McKee & Co. Viewers say that these veteran TV stars supplied the glamor and acquitted themselves nobly.

▲

THIS year Jones and Laughlin Steel Corp. celebrates its 100th anniversary with its $415,000,000 plant expansion program nearly completed. The company now has an annual capacity of 6,406,000 tons of ingots.

▲

FIFTY years ago this month, Henry Ford wheeled his first automobile out of the workshop for an initial road test.

▲

WE like the primitive life. We sleep without an electric blanket and we have no radio in our car.

▲

THE month of March lived up to the tradition it shares with October by bringing many new production records throughout the steel industry.

▲

A friend of ours says that a golfer is a guy who can walk several miles toting a heavy bag of clubs, but who has Junior bring him an ash tray.

▲

ACCORDING to the American Iron and Steel Institute, the monthly payroll of the industry for January set a new record at $285,361,000. Wage earners were employed for an average of 40.7 hours per week and were paid an average of $2.216 per hour. The total number of employees in the industry was estimated at 683,000.

SPEAKING before a meeting of the Society of Business Magazine Editors, Representative Noah M. Mason, of Illinois, emphatically stated that the excess profit tax would not be extended beyond its slated expiration date, July 1; also that the 11 per cent increase in personal income tax would be removed July 1, instead of running to its expiration date of January 1, 1954.

Before the same group, Representative Wingate H. Lucas, of Texas, expressed opposition to industry-wide bargaining because it fixed such a large portion of manufacturing costs. He believes that wages must be allowed to vary to offset discrepancies in other cost items between various plants; otherwise, some manufacturers will be put completely out of business through inability to meet competition.

▲

IN the fiscal year of 1952, government expenditures — Federal, state and local — totaled $569 for every person in the country, an increase of $141 over the previous year.

▲

THE Houghton Line says: "A raise too often has the effect of plunging you further down into debt." That's because it gives you more means to live beyond.

▲

SINCE 1941, replacement of hot dipping by the electrolytic tinning process has saved 257,000 tons of tin, valued at $495,000,000.

▲

IN May, International Correspondence Schools will enroll its six-millionth student. For 62 years this institution has helped to develop the know-how of ambitious workers, an important factor in the ascendancy of the United States to industrial leadership of the world.

▲

A reader insists he saw this in a bulletin from the United States Department of Labor: "As employment increases, unemployment is expected to decrease."

▲

L. L. COLBERT, president of Chrysler Corp., told the Economic Club of Detroit: "Working together to preserve the freedoms and incentives that have made possible our productivity advances of the past, we can keep our country strong. We have the factories and the tools to do this job. More important, we have a people endowed with common sense and a native ability to work for a common purpose. This is our greatest sinew.

▲

SPRING is the season when an otherwise rational man schemes to make grass grow so he'll have to sweat keeping it cut all summer.

▲

APPROXIMATELY $2,300,000,000 worth of research was done by American industry during 1952. About half of this, however, was supported by government funds, mostly through contracts with the Department of Defense and the Atomic Energy Commission.

Widest choice . . . for engineered instrumentation

EACH of the thousands of industrial processes presents its own peculiar problems of measurement and control. Naturally, no single instrument can solve all of these varied problems. Serious compromises would have to be made in performance, convenience, and cost.

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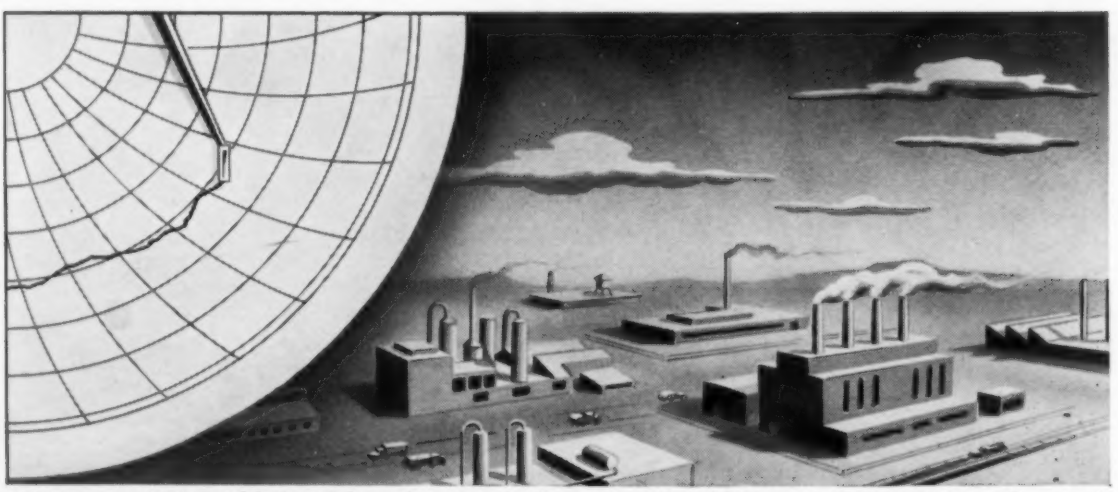

COMPLETE COVERAGE *of industrial requirements for instrumentation is at your command in the Honeywell line. Whatever you need to measure or control . . . to any accuracy . . . with any of a variety of special features . . . you'll find Honeywell instruments offer the most efficient solution.*

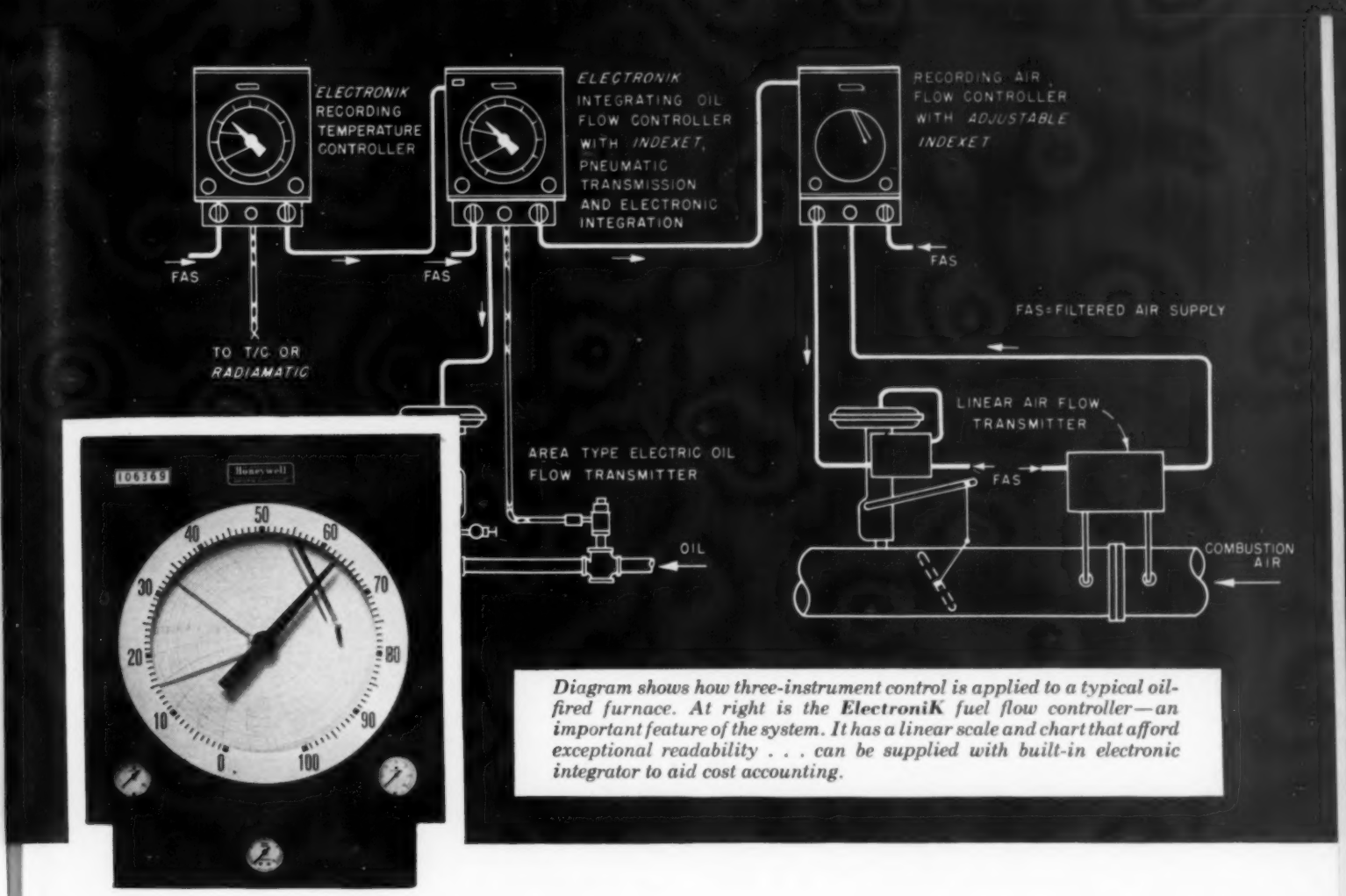

Diagram shows how three-instrument control is applied to a typical oil-fired furnace. At right is the ***ElectroniK*** *fuel flow controller—an important feature of the system. It has a linear scale and chart that afford exceptional readability . . . can be supplied with built-in electronic integrator to aid cost accounting.*

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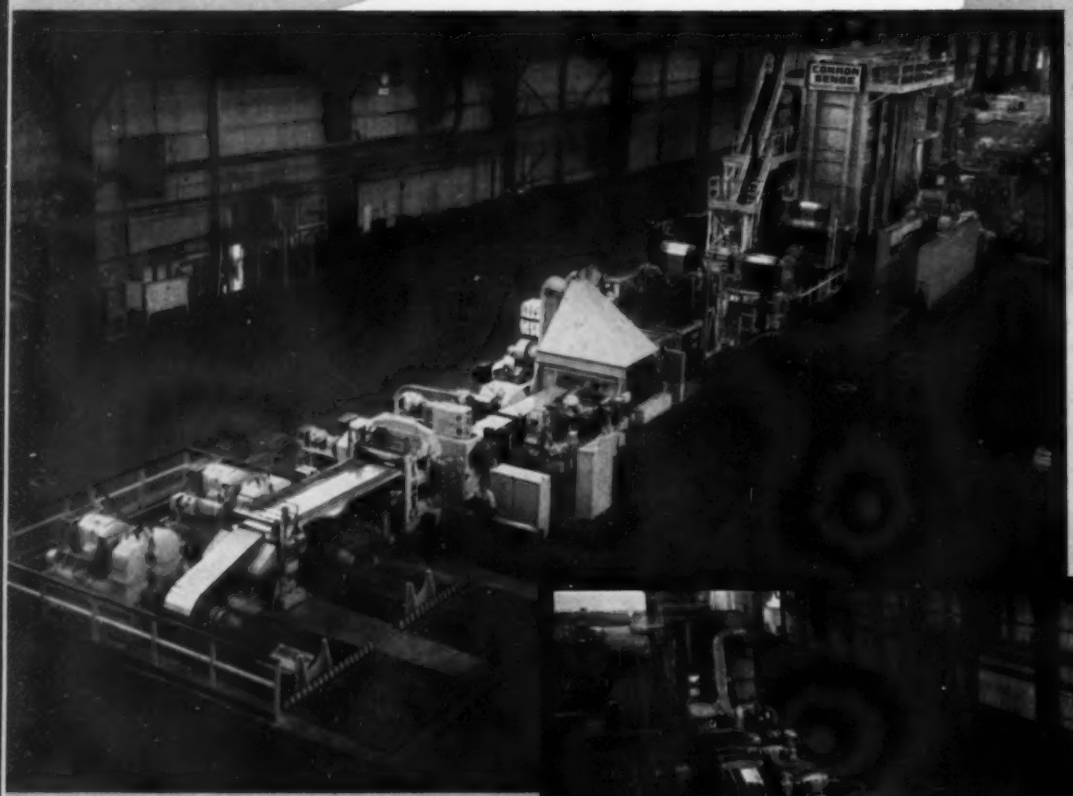

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Iron and Steel ENGINEER

APRIL, 1953 VOLUME XXX NUMBER IV

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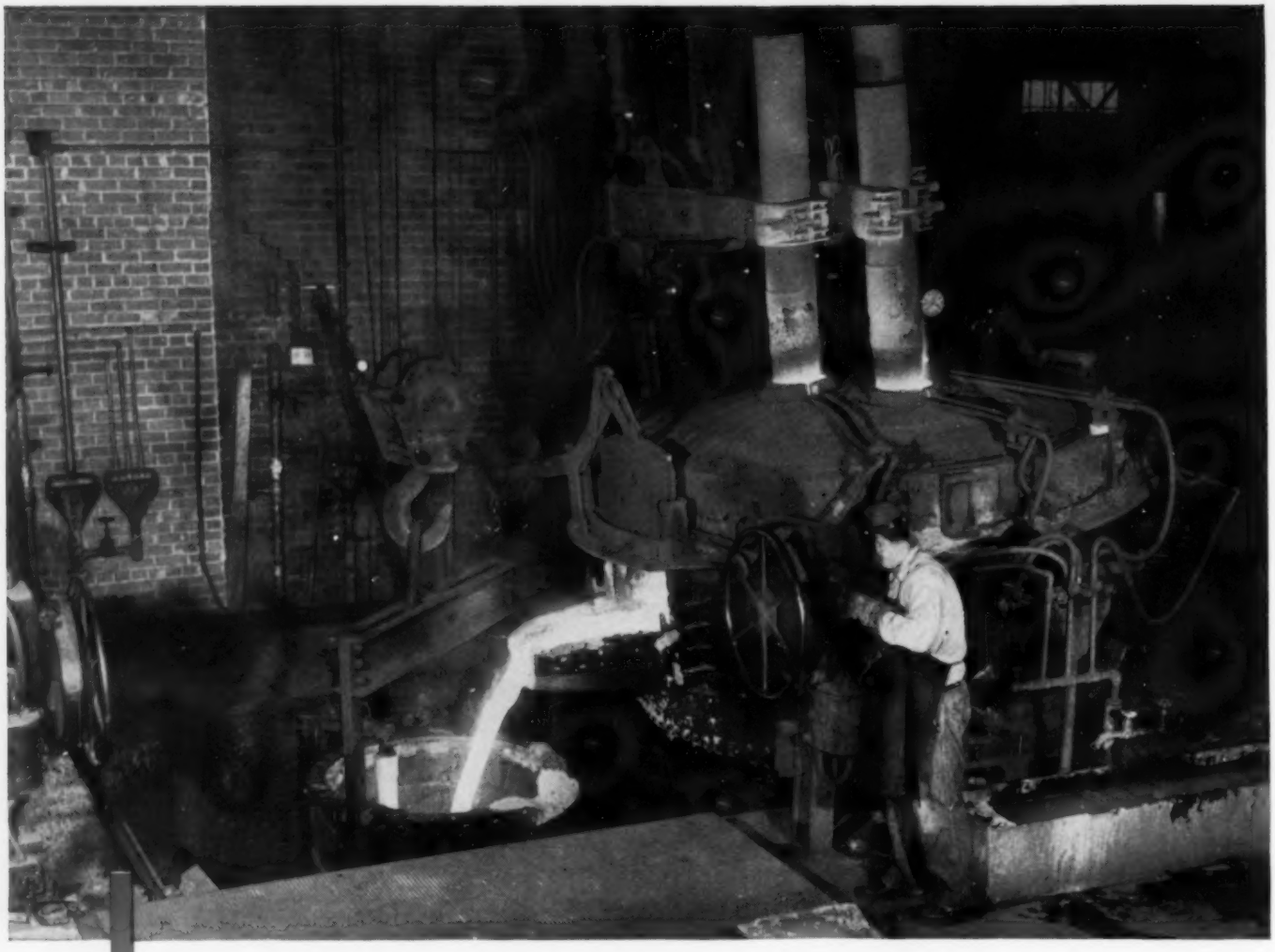

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MOORE RAPID

WHEN YOU MELT... *Lectromelt*

REDUCTION OF HANGING AND SLIPPING IN BLAST FURNACES BY AUTOMATIC CONTROL

By OTTO J. LEONE
Consulting Engineer
West Newton, Pa.

. . . . operating results with differential blowing control can practically eliminate hanging and slipping in blast furnaces . . . .

▲ ONE of the most important factors in the successful operation of a blast furnace is regularity. To obtain this regularity in a process as complex as that of the blast furnace, a proper balance must be maintained between many forces at all times; the relation between the various factors contributing to regularity can be so critical that the smallest variation in one or more of them may transform a smooth working furnace into a rough one.

Recognizing the bad effect of furnace irregularities on tonnage output, fuel consumption, dust production, costs and general safety, blast furnace operators are constantly striving to improve furnace regularity. To this end many investigations have been made to determine the various factors that affect the smooth operation of iron blast furnaces. These investigations have resulted in the following improvements in design and practice: the installation of better charging equipment to improve stock distribution; the beneficiation of raw materials by sintering, sizing and blending; changes in the design, number, size, or arrangement of tuyeres to obtain better blast distribution; control of the character of the blast with respect to its volume rate of flow, humidity, temperature and oxygen content.

In spite of the many advances that have been made, certain irregularities in furnace operation are still a major problem, mainly because the methods for control as now used are not sufficiently positive or flexible to cope with all the furnace conditions. Because of the difficulty of directly measuring or observing changes in the reduction process in the shaft proper, present day operation is based largely on interpretation of indirect observations which signify a change in process conditions in that part of the furnace between the tuyeres and the stockline. The effectiveness of any corrective operating changes based on such speculative interpretation at best can be no better than the true relation of the indirect observation to the actual process change, as well as to the accuracy with which the interpretation is made. Even if the diagnosis and judgment of the operator are accurate, some time may have elapsed before a change indication of significance is noted; this elapsed time may be too long for proper corrective and preventative action to be applied, with the result that a longer time may be required to restore the furnace to smooth operation. "Hanging" and "slipping" in blast furnaces are two such irregularities that have always plagued the furnace operator because of control limitations. Although the number of occurrences and the severity of hanging and slipping have been lessened somewhat by progressive trial and experimental changes in some of the furnace factors as noted above, present control methods still depend as much on chance as on good judgment.

This paper will discuss factors related to hanging, channeling and slipping, and will develop the logical selection of a new control method to detect and to correct furnace irregularities in accordance with the concepts outlined. The new method of furnace control which will be described gauges the changes in the "buoyant effect" of the blast furnace gases on the stock charge as an indication of the regularity with which the counter-current ascending gases and the descending stock charges are moving in the furnace shaft. The principal measurement is based on resistance changes offered by the stock charge voids to the flow of furnace gases through these voids. An installation using the control methods outlined herein has been in successful operation at the Pittsburgh Coke & Chemical Co. blast furnace at Neville Island, Pa., for some months. The installation at this plant not only improved the furnace operation, yield, and tonnage output, but also solved an air pollution problem by eliminating opening of the gas bleeder valve to atmosphere which formerly occurred during heavier slips. This method may be used

not only to alleviate the effects of heavy slips, but if used in the proper manner can actually reduce or practically eliminate hanging.

OCCURRENCE OF HANGING AND SLIPPING

Blast furnace slips are preceded by "hanging" of the stock in the furnace. A furnace is said to "stick" or "hang," when, due to some irregularity in practice or abnormal condition within the furnace shaft, a portion of the stock or charge becomes wedged at some elevation in the shaft. The stock below this level continues to settle, thus leaving a cavity under a bridge formed overhead by the wedged stock. Sooner or later after the hanging occurs, from a few minutes up to possibly hours in some extreme cases, the unsupported bridge of wedged materials gives way and falls into the cavity below; this sudden descent of material is called a "slip." In some furnaces small slips are continually occurring, while in other furnaces the charge may move only by slipping. While such stock movement may cause little disturbance to the furnace operation, this condition may develop into more prolonged hanging periods which in turn result in chronic heavy slipping. When a furnace hangs, the level of the stockline does not change, or it may possibly move faster on one side. In other cases in which the stock in the furnace is moving but where the rate of stock movement in the lower zones of the furnace may be faster than in the upper levels, thus causing a cavity or stock separation between furnace levels, but with no apparent hanging or complete stoppage of stockline movement, sudden increases in movement of the slower-moving stock into the cavity below result in small slips or in a jerky stock movement. As a rough rule, when a furnace is working "stiff," and if there is no movement of the stock for periods of about 20 minutes or more, most operators consider the furnace as "hanging" or " sticking"; under such conditions it may be necessary to "check" the furnace by reducing the rate of wind put through it, to reduce the blast pressure which supports the bridged material sufficiently to cause the material to "slip" into the cavity below.

VISUAL INDICATIONS OF HANGING AND SLIPPING

A hanging condition may be indicated by the record of the stockline recorder, the recording pen of which will also indicate the time duration of the hanging period. The pen may also indicate the time of occurrence and the amount of stock level movement during slips.

Other indications by which the operator may detect possible hanging conditions are:

1. A slackening of the rate of charging.
2. By noting changes in temperature and pressure of the top gases, or, if gas analyzers are available, by a change in gas analysis; also a simultaneous change in the dust content of the gases.
3. By increased pressure of the blast corresponding to other furnace conditions.
4. By changes in the character of the slag.

Unfortunately, most of these indications cannot always be relied upon positively. Also, the hanging may already have reached an advanced stage by the time these trend indications are noted, in which case only restorative rather than preventive measures may be applied. The method to be described in this paper is primarily a preventive method that attempts to correct causes of irregularity in the initial stages before the furnace operation is adversely affected.

INDICATIONS OF SLIPPING

The occurrence of slipping may not be easily noticeable if it is light or, if the slip is violent, gas and dust may be ejected from the bleeder valves or explosion doors in the furnace top. Heavier slips may be accompanied by a muffled roar which is more or less violent; in some cases explosions have actually occurred in the furnace top. The violent eruptions may last for several seconds during light slips or, the ejection of dust and gases to atmosphere during a heavy slip may continue for longer periods up to 15 seconds or more. Some measure of the severity of a slip is indicated by the displacement or distance traveled during the slip by the top gas recorder pen from its normal position at which it rested before the slip. Sometimes the pressure increase caused by the gas blowing through the stock during a slip is so severe that the top gas pressure recorder is not of sufficient range to show the extent of the top gas pressure rise. As soon as the slip has subsided, the recorder pen returns to a normal position on its chart.

THEORIES CONCERNING THE NATURE AND PROBABLE CAUSES OF HANGING AND SLIPPING

There being no means of direct observation of the chemical and physical processes occurring in the blast furnace, one can only conjecture as to the mechanism of hanging and slipping from a study of the experiences and observations of operators and investigators. On the basis of such information, a number of "practical" theories have been proposed as to the nature and probable causes of hanging and slipping.

In addition to the concepts based on operational experience data, attempts have been made to formulate theories based on analytical and experimental methods. During the past quarter century, the U. S. Bureau of Mines has conducted many studies relating to gas-solid flow in the blast furnace; these studies have been made both in the field and in scale models in the laboratory. By borrowing powerful techniques of analysis from other fields, these investigators have provided a new insight into the mechanisms of hanging, channeling, and slipping. Papers based on these experiments stress the importance of such factors as particle size, gas velocities, voidage, and uniform gas and stock distribution on furnace regularity. The necessity of good gas-solid flow and contact to obtain smooth furnace operation has been emphasized by such investigators as Furnas, Royster, Joseph and others.

Many of the concepts proposed by the above men on hanging, slipping and channeling are based on studies of gas flow phenomena through beds of non-homogeneous solids. Attempts have also been made to apply the laws of similarity and dimensional analysis to these studies in order to compare experimental data

with similar conditions in the blast furnace; from these studies certain general theories on furnace behavior have been deduced. While it is generally believed that conditions in the blast furnace cannot be duplicated in scale models in the laboratory, nevertheless, the results obtained from controlled tests on blast furnaces, and from other observations of furnace conditions similar to those encountered in the laboratory, appear to affirm indirectly many of the conclusions of these investigators.

More recent investigations on the behavior of gas flows through packed beds in catalytic reactors, oil shale retorts and roasting equipment in the chemical process field also tend to confirm many of the general theories proposed by the earlier researches. It is interesting to note, for example, from one report, that channeling in catalyst beds of commercial hydroformers reduced the efficiency to approximately 55 per cent, showing therefore, that the bad effect of channeling in other processes parallels its effect in the blast furnace, in direction, at least.

It is not within the scope to discuss these theories in detail. However, a brief review of some of the theory and views may be in order and will be covered insofar as it pertains to the selection of the new control method as a logical means to reduce hanging, channeling and slipping in the blast furnace.

"PRACTICAL" VIEWS ON HANGING

Hanging has been classified generally according to the location in which it occurs in the furnace as "top hanging" and "bottom hanging," with distinct causes attributed to each type. In addition to these main types, some operators classify another type of hanging which occurs in the zones midway between the mantle and the top, the cause of which is attributed to a combination of top and bottom irregularities. Still another type of hanging is associated with a low voids condition within the furnace shaft, in which the hanging results from high lifting velocities through some part of the furnace, as for example, through the center of the charge. Another type of hanging referred to is that resulting from scaffold formation, although this type is also associated with top or bottom hanging.

"Bottom hanging" is said to occur in the space from the lower bosh to the top zone of slag formation. This irregularity is associated with improper slag conditions with regard to basicity or viscosity, excessive refractoriness caused by variations in materials charged, or with improper blast temperature or moisture content which may affect the fusion properties of the slag or cause the fusion zone to shift.

With regard to basicity of the slag, too limey a slag may produce bottom hanging. It is well known that an excess of lime and alumina can make a slag too refractory and increase the fusion point. Under such conditions it is more difficult at the existing furnace temperatures to keep the slag fluid, with the result that the possibility of hanging is increased.

Under certain conditions some of the slag may stick to the furnace walls. If this slag contains a large amount of fine coke dust and carbon dust, it may be too refractory to be melted loose from the wall, and may start a scab formation. In the presence of other limey slags, iron oxides, lime dust, coke and carbon dust, and with potassium cyanide as a binder, it is believed that the weight of the stock column may compress this mixture to adhere to the plastic scabby acretion and enlarge it. Additional accumulations of material finally result in the formation of scaffolds which project out into the furnace to diminish the area available for flow, thus increasing the gas velocities and the supporting effect of the gases on the descending burden. Such a condition affords a support for the charge to rest on and to bridge across.

In addition to the above causes, poor bosh design may promote scabbing and hanging. Improper cooling of the bosh is another cause.

"Top hanging" may be attributed to many causes. Some operators believe the hanging to be caused by a combination of carbon deposition in excessive amounts, and a mechanical wedging with or independently of carbon deposition. It is also thought possible that irregular charging or variations in the amounts or character of the materials charged may upset the equilibrium conditions in the chemical reactions taking place in the upper reduction zone, where temperatures of between about 750 and 1300 F normally exist, in a direction to cause excessive carbon deposition. If the above mentioned conditions, or the furnace temperature conditions are such that the reaction $2CO = CO_2 \pm C$ is driven toward the right to deposit carbon excessively, the finely divided carbon deposit will fill a large part of the voids space in the charge, and will cause the stock to swell, thus decreasing the channels available for gas flow, and increasing the resistance to gas flow through the charge.

It is not necessary for the excess carbon to be deposited throughout the charge across the furnace area; conceivably, the deposition may be concentrated in a limited part of the charge, but may be enough to wedge the adjoining material firmly in the throat of the furnace shaft to increase the resistance to gas flow. Variations in the amount of coke charged as well as the position of this excess carbon deposit may induce hanging.

With reference to the relation existing between excess carbon deposition and hanging, there is a school of thought which claims that the excessive deposition is an effect and not the cause of hanging; some very good evidence has been offered to substantiate this theory. Which concept is correct does not matter in this discussion; the important thing to note is that the physical effect of excessive carbon deposition and of hanging, regardless of which occurs first, is to increase the pressure drop through the furnace charge

Top hanging with consequent excess carbon deposit has also been attributed to the following mechanical causes: improperly designed offtakes; projections and accretions built up on the wall; eroded depressions or channels in the wall.

Hanging may also be caused when the stock has a tendency to travel faster in the center of the column, and when at the same time fine coke or deposited carbon, stone and ore dust accumulate on the sides. Should this tendency become quite pronounced, the interior part of the charge may rest or wedge on the

slowly descending ring near the walls to provide a foothold to start hanging. Unbalanced thermal conditions in the furnace may result in raising the fusion zone to higher levels in the furnace shaft to provide excessive temperatures in the upper zones, irregular working and hanging.

Poor practices in the operation of the furnace are a principal cause of hanging and slipping. For example, changes in stock distribution due to improper charging methods are known to cause size segregation which may induce irregular stock movement. Carelessness by the skip operator in maintaining the correct stock level, especially in allowing it to reach lower levels than normal, may be another cause. The practice of charging into the furnace of considerable quantities of large-size materials such as cast house scrap within a short period, to provide too open voidage spaces in the charge, and especially in some cases if too high a hot blast temperature is carried for the existing furnace conditions and wind rate may cause "blowing through" of the gases. At times hanging is caused by improper timing of stove changes, as for example, too soon after a furnace cast, particularly if the furnace charge may have packed tighter than usual from the reduced wind through the furnace caused by prolonged opening of the snort valve. Such prolonged reduction of wind put through the furnace greatly reduces the voidage spaces available for gas flow in the furnace, which after the cast may require as much as a half hour or so for the stock charge to recover its normal expanded voids condition necessary for proper stock charge movement. Under these conditions any reduction in wind put through the furnace or reduction in blast pressure during the stove change, if the furnace charge has not recovered its normal stock movement, may pack the furnace to the point of considerably prolonging the recovery time for the charge to "move off," or a period of hanging may be started. One of the most common causes of hanging, of course, is the practice of overblowing the furnace.

CONCEPTS OF GAS FLOW THROUGH THE BLAST FURNACE AND ITS RELATIONSHIP TO OPERATING IRREGULARITIES

Attempts have been made to explain the causes of hanging, slipping and channeling on the basis of experimental studies of gas flow phenomena through packed beds of broken solids. Comparisons of the experimental conditions with those that occur in the blast furnace have also been made on the basis of flow analogy by applying laws of dimensional analysis. Unfortunately, it does not appear possible to apply strictly the laws of similarity and dimensional analysis to the study of quantitative gas flow relationships in the blast furnace with any reliable degree of accuracy. In the first place, the requirement for geometric and dynamic similarity necessary for such comparison is not present in the heterogeneous blast furnace charge which provides the voids pathways or channels available for flow of gases. Many other considerations which cannot be discussed adequately here prevent strict applications of such comparisons and of generalized flow laws to the problems. Such researchers as Furnas and others recognized these limitations and introduced new factors into the flow formula to take care of such variables as shape differences, wall effects, particle size and roughness factors, and differences in degree of packing. They also used modified Reynolds numbers and other flow coefficients and criterions in attempts to determine the effects of varying one or more of the flow conditions through a bed of broken solids. From a practical standpoint, there is actually no reliable method for accurately calculating the effects of changes in flow variables in the blast furnace. One has only to refer to Figure 1, for example, to observe how the pressure drop corresponding to such fixed conditions as blast volume rate, hot blast temperature, and an almost constant stockline level, may vary several pounds even in a relatively short period of time of a few minutes to a half hour, and to realize the apparent inability in determining a reasonably accurate flow formula for the blast furnace. The charts in Figure 1 are taken from one day's operation of the Neville Island furnace prior to the installation of the differential blowing control method. There are so many variables that cannot be determined that it is impossible to calculate or predetermine the pressure drop.

In spite of the impossibility of deriving a satisfactory rational formula for the blast furnace in order to analyze furnace behavior, it has been possible by investigating gas flows through carefully handpacked beds of solids of various shapes and sizes, to deduce certain generalizations in gas flow and stock charge relationships. By utilizing a certain amount of simplification, operational experience and common sense logic with these findings, it has been possible from a qualitive standpoint at least, to analyze the effects of varying one or more factors in the blast furnace gas-solid flow process on the furnace behavior. It is not important for the proper selection and application of the control method described in this paper, therefore, to know the exact quantitative effect of a change in one or more flow factors or of other furnace variables; it is only necessary to know whether a change in direction and magnitude of the variables will increase or decrease the tendency to promote irregular working of the furnace. Knowing this, proper steps may be taken to counteract such tendencies.

Despite the previously mentioned limitations for rigorous application of gas flow relationships to the study of furnace behavior, by combining the results of experimental work and experience in the operation of furnaces, the following explanations of generalizations have been made concerning the behavior of blast furnaces:

The blast furnace charge settles under the force of gravity against the counter-current movement of furnace gases which exert an upward buoyant force on the charge. The only path for the flow of blast gases through the stock charge is that provided by the voids in the charge. It has been estimated that a blast furnace charge using Lake ore may have perhaps 35 or 40 per cent voids, but because of the many dead spaces which exist, the effective free voids available for gas flow may be only 10 or 12 per cent. A reduction of only a few per cent of the voids available for flow when the furnace stock stiffens or packs more densely will greatly increase the resistance to gas flow.

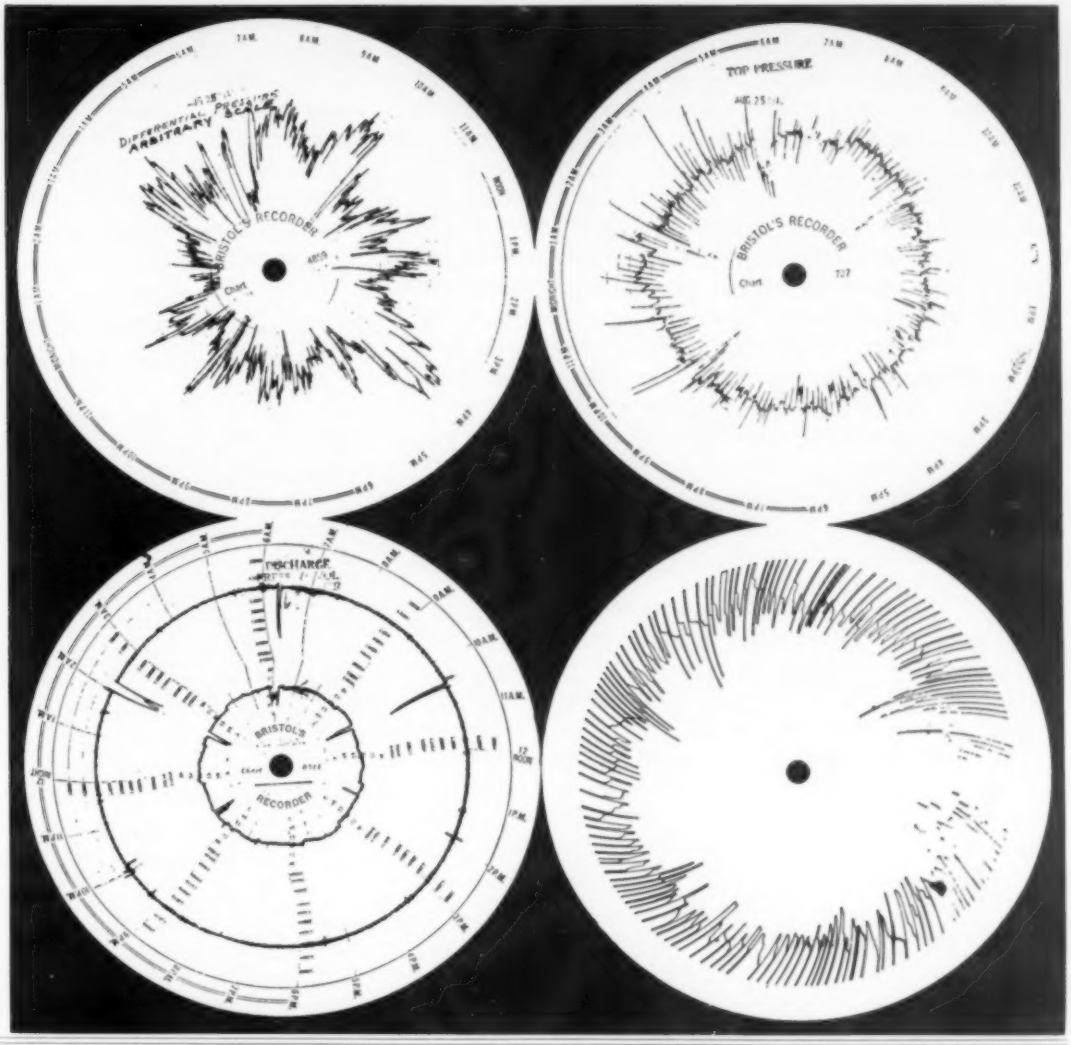


Figure 1 — These charts are for one day's operation of the Neville Island furnace before installation of the differential blowing control method. Chart in lower right hand corner shows stockline level.

If the overall resistance of the charge becomes too great, the downward movement of stock is opposed by the increased high pressure and friction forces and a hanging condition results. When this occurs the pressure drops through the charge is higher than normal; if the blast pressure and blast volume are reduced, the charge settles again and the stock usually resumes its normal downward travel.

In a charge of given effective voidage, increasing the blowing rate or the hot blast temperature, or both, will increase the pressure drop through the furnace stock. If this pressure drop is too high, it may cause hanging, channeling, and slipping, with resultant high dust production and reduced efficiency.

Because of the higher pressure drops which result from excessive blowing rates, there may be a tendency for small particles to become suspended in the gas stream if the gas velocities exceed critical values. Furnas has shown that when the critical velocity is exceeded by a gas carrying particles in suspension, this further increase in velocity will cause the suspended particle to be lifted and carried upward in the furnace with the gas stream. He showed that the effect of the change to lifting velocities in a bed thus fluidized was to reduce the pressure drop through the charge. It was also found by Kinney in Bureau of Mines research that an unequal velocity distribution exists across the area traverse of each plane elevation of the blast furnace charge. If some parts of the charge are packed more densely than adjacent parts so as to provide parallel flow paths of variable resistance, the gas flow will follow the paths of least resistance, thus causing a disproportionate volume of gases to flow through the more open flow channels and to bypass that part of the charge which is less permeable to flow. Once channeling begins, it may initiate a vicious cycle of more channeling that is self aggregavating and which may reach serious proportions with high dust carrying capacity. If the more loosely packed section of the bed of solids occurs near a point of higher velocities, because of the velocity distribution mentioned above, there will be a tendency to channel where the higher lifting velocity exists.

The dust carrying power of gases varies approximately as the square of the gas velocity. In order to reduce the tendency for gases to carry dust out of the furnace, and to channel, it is desirable to keep the gas velocities below the critical velocity. Since high pressure drops through the blast furnace charge also indicate high gas velocities, a method of operation based on a measurement of changes in pressure drop will provide such control.

The void conditions in a non-homogeneous bed of solids, and in a blast furnace, depend not only upon such physical characteristics of the solids as density, porosity, particle size and shape, but also upon certain furnace factors which determine initially how the particles are placed in contact with each other when

charged into the furnace; these furnace factors also affect the relative locations and movements of the solids after the burden is charged, and in this way affect the void conditions. The factors include: the furnace height, which influences packing; wall batter, which affects the relative movements and relocation of solids as they flow downward; the area and contours of the furnace. In addition, the voids are affected by the type of charging and sequence of charging used, which influences the stock distribution, size segregation and breakage of solids. In the lower part of the furnace, the void conditions are affected by the volume reduction of the solids as they are reduced, melted, or are consumed by combustion. The viscosity of the slag has a decided effect on the friction offered to gas flow; a limey, viscous slag condition is one cause of high pressure drops through the charge.

CONSIDERATION OF FACTORS TO BE CONTROLLED

Study of blast furnace phenomena shows that the following factors dominate the behavior and operation of the process:

1. The furnace factors, which include the design characteristics and the physical make-up of the furnace equipment.
2. The burden factors, which depend upon the character of the ore mix, stock distribution, burden ratio, height of stock column; density, size, and degree of packing of solids; combustibility, ash, and sulphur content of the coke; slag volume, viscosity, and chemical nature of the slag; and the effective voids of the charge.
3. The air and gas factors, such as the pressure and volume of the air blast gases; also the velocity, moisture content, and temperature.

Of the above factors it is to be noted that practically all instrumentation on blast furnaces has been applied toward the measurement or control of some property or condition of the air and gas factors. The recorders on the stock line and distributor rotation are exceptions to this statement.

With respect to the furnace factors, once the furnace is designed and built, the operator has no further control until a structural change is made. Consideration of this factor as a control possibility can therefore be eliminated at once.

About the only control the operator has of the burden factors, once the charge is dumped into the furnace, is to control the height of the stock level. By control of some of the air factors, a degree of indirect control of burden factors is possible, such as the control of temperature of the stock, the slag viscosity, or the degree of packing of the stock column. Beneficiation of ore and size selection of raw materials afford another indirect method of control, but once the material is in the furnace, there is no control against powdering of the ore, or crumbling and crushing of the coke.

The reason for concentrating instrumentation efforts on the air and gas factors will be further appreciated when it is realized that any change in the burden as a corrective measure takes up to ten hours or more to reach the furnace bottom, whereas a change in wind rate, for example, will take effect on the gas velocities and their buoyant properties within the furnace in a matter of seconds. Essentially then, the use of burden factors such as charging extra coke blanks, scrap charges, or changing the burden ratio by adding more ore, are "long-time" corrections which are not adaptable to instrumentation methods. A control method based on some property of the air and gas factors, on the other hand, affords a fast correction in much shorter time, and provides a better opportunity to apply instrumentation methods.

REQUIREMENTS TO BE MET IN SELECTING A CONTROL METHOD

It is axiomatic among control engineers that to properly control a variable, one must first measure a condition that is affected by the changes of the variable, and to use that measurement as a basis for control. The measured function or signal must always be in a proper direction to denote the true trend of the variable change. Further, it is desirable that a small increment change in the variable condition produce a corresponding appreciable change in the measured signal, so that any process variations may be corrected as soon as possible. The selected measurement must be adaptable on the furnace.

The prevention or reduction of hanging, channeling, and slipping in blast furnaces by manual or automatic methods seems almost an impossibility at first thought, in view of the many factors which have been attributed as causes. However, it can be shown that these factors may be resolved into a "common denominator," in terms of a practical measurable function which can be correlated with all the above factors either by cause or effect. Whether they be attributed to thermal, physical, or chemical causes, the fact remains that "hanging, channeling, and slipping" are physical results; this fact suggests consideration of simple physical measurements as possibilities to detect the changes in the variable factors.

Lest it be inferred that a cure-all for the furnace man's mistakes and troubles be furnished by the selected control system, such is not the intent by any means; the control method should be just another tool to give better furnace control. It must be understood that the operator will continue to exercise the same care and judgment in burdening and operating the furnace as is now used without such control.

CONTROL OF PRESSURE DROP TO REDUCE HANGING, CHANNELING AND SLIPPING

A consideration of the previous analysis into the causes of hanging, channeling, and slipping, and of the various possible measuring and control methods, indicates that a measurement or control of the pressure difference between any two successive elevations of the stock charge will provide a practical, direct, and effective method for detecting changes in the character of the counter-current gas-solids flows in the blast furnace. Alternately the pressure difference may be measured and controlled between the blast pressure before the tuyeres and the top gas pressure. This method satisfies the conditions given above as requirements to be met in selecting a proper control system.

First, the differential pressure method of control is positive and direct; any hanging, channeling, and slipping, or a change in the voids condition will immediately be reflected in a change in the pressure drop through the charge.

Secondly, the method is easily adaptable to instrumentation.

This method also satisfies the requirement for producing relatively large changes of the measured signal for changes of small magnitude in the process variables. For example, it has been determined that the pressure drop through the blast furnace charge for a given state of voidage and material size varies as some power of the wind volume blown, or similarly as the same power of the gas velocity (average); this exponential power value has been given as 1.5 by some, and with larger values up to two under conditions found by others. For ease of computation, assuming the law of squares to govern the relationship, a 10 per cent increase on wind volume would theoretically increase the pressure drop through a given state of charge voids by 21 per cent.

It may be shown theoretically that changes in particle size similarly affect the pressure drop through a bed of solids to a degree greater than that indicated by a linear relationship. It has been stated in the literature that in general the resistance to gas flow in a bed of solids varies inversely as the 1.2 power of the diameter of the solid particles; in other words the smaller particles offer more resistance than larger ones.

The effect of size segregation and of channeled beds on pressure drop in a bed of broken solids on gas flow has been determined by Furnas and others. Furnas has shown that the resistance to gas flow in a uniformly mixed bed of solids of two selected particle sizes, theoretically may be 259 per cent of the value of pressure drop it would have in channeled flow; in the test he assumed that 50 per cent of the particle sizes were twice the cross-sectional area of the rest of the particles. More recent researchers, also by testing specific types of beds, have tried to express mathematically the effect of changes in the degree of packing on pressure drop by using modified friction factors and other coefficients. While there is wide variation in the results of these investigators, probably due to differences in the test conditions, nevertheless they all show that the pressure drop is directly affected by changes in degree of packing, and at an exponential power relationship that is substantially greater than linear.

A further argument in favor of the differential pressure method may be seen by simplifying the statement of the gas flow problem in the blast furnace and by applying some common sense thinking to it. In a very crude way, by considering the gas flow behavior in each small layer of the furnace charge, the summation of the resistances of which adds up to the total pressure drop through the furnace, each of these layers may be roughly compared to a variable orifice flow metering device which is used to purposely generate pressure drops. In the case of the variable orifice flow measuring device, it can be shown that at constant mass flow conditions, the pressure drop resulting from fluid flowing through the orifice is inversely proportional to the second power of the orifice area. Since the blast furnace charge also behaves in some respects like a variable orifice, it may be considered in terms of an "equivalent orifice," the effective flow area of which will depend upon the summation areas of the voids channels available for flow. While it is appreciated that the analogy used is very crude, it does illustrate that a very small change in the voids condition or the degree of packing in the stock charge can result in a relatively large change in pressure drop.

The proof that changes in degree of packing have an appreciable effect on the pressure drop can best be seen by observing chart records of pressure drop changes just before, during, and after a hanging period, when the furnace slips or starts moving normally again, or during and after cast periods. If the wind through the furnace is reduced considerably during casting and then is put on again at the same volume rate as before the cast, the pressure drop will usually be somewhat higher for the same furnace burden, wind rate, and blast temperature conditions that existed before casting, its value depending upon the degree of packing. With constant wind rate on the furnace after the burden has "moved off" after a cast to again assume a normal expanded voids state, the differential pressure again returns to a normal range. The magnitude and rate of increase of pressure drop during this period is somewhat greater than that of either the top gas pressure or of the blast pressure. Depending upon the change in the degree of packing and the rate of increase in top pressure during this period, there may or may not be any reliable relation between blast pressure and pressure drop. If a slip occurs as the result of checking the furnace to help the charge to move, or as the result of a slip, blowing through of top gases, or of rolling action of the charge in the furnace, the top gas pressure will show a sudden increase, the pressure drop will decrease very quickly and to a magnitude at least equal to the increase in top pressure, while the blast pressure under these conditions may or may not show any change; if it does it may be small by comparison.

Under the discussion of requirements in selecting a control method above, it was stated that the control signal must always be in a proper direction to detect the true trend of the variable change. A study of the effects of the various irregularities on the pressure drop through the stock will show that this requirement can be met by the differential pressure control system. Chart records obtained in the actual operation of the presure drop controller also confirm this, as will be shown later.

One may conclude from the above arguments that from an instrumentation viewpoint, a suitable measurement index that will be positively indicative of conditions that lead to hanging, channeling, and slipping, and at the same time will provide a means for easy and fast correction of irregularities, is that of the pressure drop caused by the flow of gases through the stock charge.

THE DIFFERENTIAL BLOWING CONTROL SYSTEM AT NEVILLE ISLAND

There are several methods by which the differential pressure control system may be adapted to a blast furnace; several of the methods will be described, includ-

ing those tried at the Pittsburgh Coke and Chemical Co. at Neville Island.

The blast furnace has a hearth diameter of 22 ft-0 in., with a nominal rated capacity of 850 tons per day. Wind is blown through 12 tuyeres by turbo-blowers equipped with constant volume controllers. Maximum wind blown on this furnace has been up to 61,000 cfm. The furnace is equipped with four stoves which preheat the blast to about 1050 F. In 1950, the furnace was completely relined and a carbon block hearth installed. Another improvement was the replacement of a steam driven skip hoist by an automatic electric hoist.

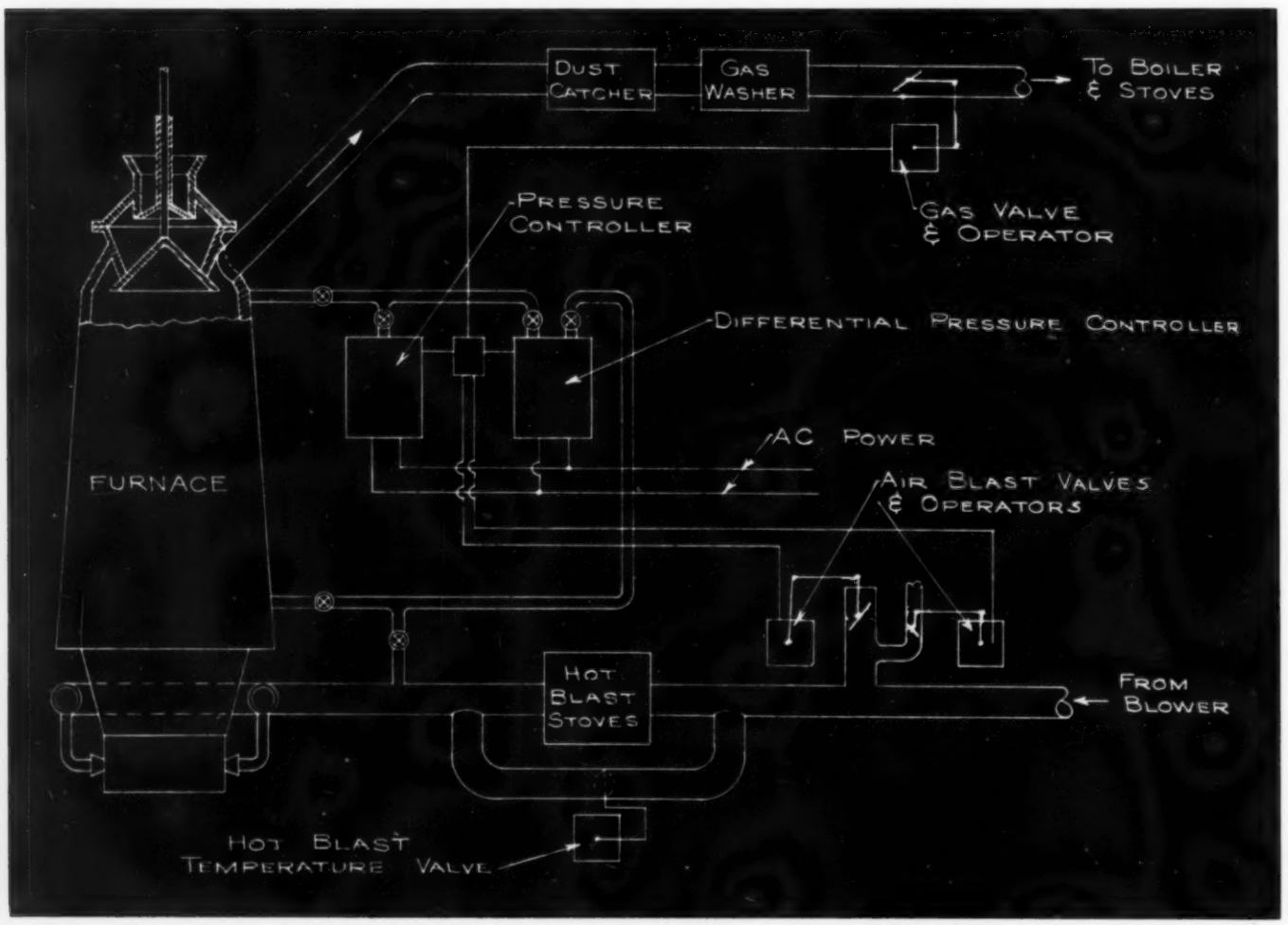
The furnace produces merchant grades of pig iron which are cast in the pig machine. Because of the variation in order specifications in this plant as compared to all-basic practice in larger integrated steel plants, the furnace burden must be changed more frequently at this plant than is the case in other plants. This condition makes it more difficult to maintain smooth operation from day to day.

Most of the operating results with the control system as covered in this paper were obtained before the furnace was relined with carbon, near the end of the campaign, and under very bad operating conditions when the old lining was in poor shape. Because this was a one-furnace plant at the time of test, all changes made were gradual in order not to upset the furnace practice. Also, because of the wide variation in burden practice, it was difficult to control furnace conditions in a true scientific sense. For this reason the differential pressure control system was operated under the day-to-day conditions as they occurred. No attempt is made in this paper to correlate quantitatively the observed controller results with such factors as burden ratio, coke rates or chemical data; the main object of the operation of the differential pressure control system was to observe its effect on the physical working of the furnace, especially with respect to the reduction of hanging, slipping, and channeling; on bleeder valve operation and dust production; and on furnace yield and tonnage output of iron.

DESCRIPTION AND OPERATION OF THE CONTROL SYSTEM

Figure 2 shows schematically one method of adapting the control system to a blast furnace, and as shown is the method now being used on the furnace. The equipment includes a differential pressure controller and a top gas pressure controller which may be mounted on a control panel as a package, complete with interlocking accessories to properly interconnect the control actions of the two controllers. Two air-operated diaphragm control valves of different sizes are shown connected in parallel by piping to the cold blast main on the high pressure side of the furnace; the opening of

Figure 2 — Sketch shows one scheme for adapting the differential pressure control system to a blast furnace. This scheme is now being used.



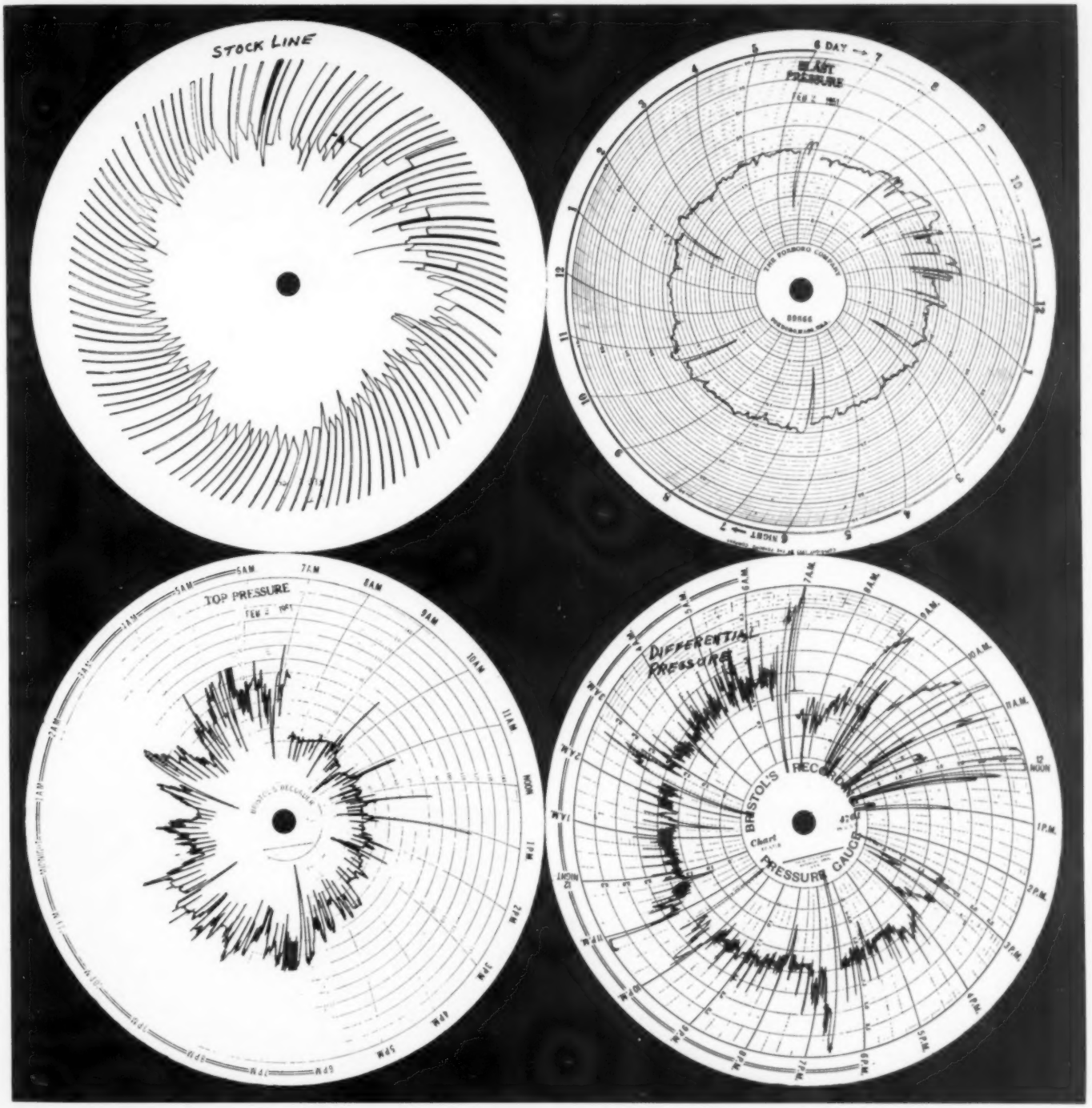


Figure 3 — This chart which covers a period in which the differential control was both off and on illustrates the effect of the control operation.

either valve in response to controller action relieves blast air to atmosphere. A third control valve with power operator is shown in the gas main on the discharge side of the furnace, immediately after the gas washer.

By proper setting of the control system, the pressure differential controller can selectively throttle either the gas control valve after the washer or the smaller of the two atmospheric relief valves on the blast main or high pressure side of the furnace.

The top pressure controller may be interlocked with the differential pressure controller in such manner that the top pressure valve dictates whether the differential pressure controller is to operate the control valve in the gas discharge main only, or the smaller atmospheric relief valve in the blast main. The control system also incorporates another control element which in the case of a slip overrides the modulating control actions on the control valves in the gas main and on the smaller atmospheric relief valve in the blast main, to quickly open the larger relief valve in the blast main wide open to atmosphere.

The operation of the system is as follows; the control index on the differential pressure controller is set at a pre-determined value on its scale which experience dictates as suitable for the wind volume and other furnace conditions. Preferably, the setting is such that the controlled valve is throttling. The operator sets a selector station which connects the differential pressure controller to either the gas control valve or to the

smaller of the two atmospheric relief valves on the blast main.

Assuming that the differential pressure controller is set to throttle the control valve in the gas main, a change in pressure drop to a value greater than that corresponding to the set control point will tend to close the gas valve, to reduce the pressure drop and lifting velocities of the gases through the stock. A change in pressure drop to a value below the value corresponding to the control point will cause the gas control valve to move to a more open position, to increase the pressure drop through the furnace and to return the recording pressure drop to the set control point. The operation is such that the slightest change in pressure drop caused either by packing of the stock, or by too open a charge, for example, will make the control valve seek a new position to return the pressure drop to the desired control point.

Should the gas control valve reach its maximum point of travel toward the closed position, as in the case of a very tight furnace, and if the pressure drop pen is still above the set control point or, if before the valve reaches its maximum position, a value of increased top gas pressure has been reached which it is not desired to exceed for obvious reasons, at this value of top pressure the pressure controller will transfer any further control action to the smaller atmospheric relief valve in the cold blast main. The continued control action by throttling of this relief valve to reduce the wind passing through the furnace will tend to further reduce the pressure drop and velocity of the gases through the stock. Should this further action still not be enough to return the pressure drop to the desired control point, or if for any reason the top gas pressure reaches a second high pre-determined value, or if a slip occurs, the larger atmospheric relief valve in the blast main will quickly open wide to relieve a large volume of wind from the cold blast main to atmosphere; this latter action reduces the gas velocities in the furnace fast enough to prevent the top pressure from reaching a high enough value to open the bleeder valve or explosion doors.

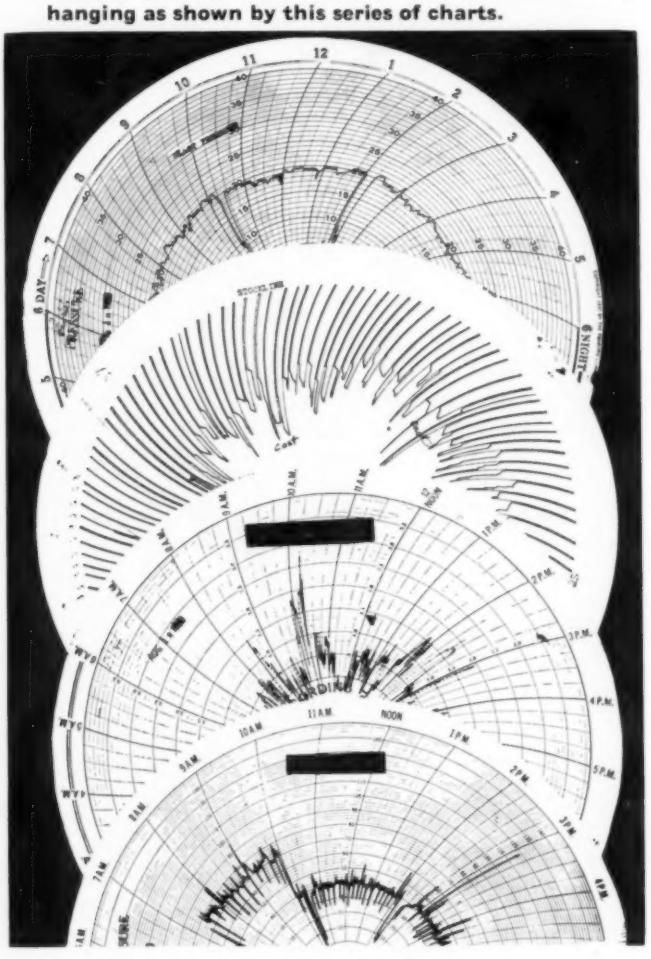
Figure 3 is an example of the type of control that is obtained by the mode of operation just described. From 8:00 am until 3:00 pm the differential control was not on the furnace; for the rest of the day the furnace was on control. It will be noted that the available top pressure was used as much as possible to keep the differential pressure as constant as possible, the top pressure being increased as the furnace charge tried to stiffen to gas flow, and the top pressure being reduced as the differential pressure pen deviated below the set control point. The wide variation in pressure drop during the uncontrolled period will be evident from the figure. At noon wind was taken off the furnace to get the charge to move after it had been hanging for more than three hours. When control was put on the furnace again the blowing rate was increased again.

Instead of having the differential pressure controller operate valves as shown in Figure 2, it may send controlled output loading pressures to a volume controller at the turbo-blower, to vary the blast volume as required to control the pressure drop through the stock to a desired value. Alternately, the differential pressure controller may operate a restrictive valve in the blast main, to add more or less resistance between the blower and the furnace, as required to control the pressure drop. With either method the control system may have to take into account the surge characteristics of the blower.

Under the method of Figure 2 in which a gas valve after the washer is controlled, the top gas pressure may be permitted to swing as required to satisfy the control action of the differential pressure controller. Alternately, the top gas pressure may be controlled to a constant value, while at the same time the pressure drop is controlled to a constant value below a critical value that may cause irregularities. This method however, does not appear to be as effective as one in which the top pressure is modulated to higher or lower values as the differential pressure varies, particularly on furnaces which have limited control means. Also, by modulation of the top pressure, particularly on low pressure furnaces or on any furnace where blast air volume rate must be varied in addition to the top pressure, the top pressure modulation in response to changes in pressure drop will result in less bleeding of blast to atmosphere to maintain a given pressure difference through the furnace.

Since some furnace operators are now using a moderate increase in top pressure, and others are operating at much higher top pressures a few remarks on these types of furnace operation may be in order. Actually, there is nothing new in the use of a moderately in-

Figure 4 — Slight increases in gas density obtained from increasing top pressure will not keep a furnace from hanging as shown by this series of charts.



creased top pressure, which was suggested more than thirty years ago for the purpose of charging flue dust back into the furnace, and to reduce dust carry over. Many references may be found in the literature.

Observations made at Neville Island indicate that while a moderate increase in top pressure may probably reduce dust carry over, this is usually true only when the furnace is working regularly. It has been found that the slight increase in gas density obtained by merely increasing the top pressure from 35 or 40 in. of water to 70 or 80 in. of water will not keep a furnace from hanging. The reason for this can easily be seen by reference to Figure 4, which shows the variations of pressure drop through the furnace recorded simultaneously with stock level variations and blast pressure variations, at two different levels of maintained top pressure. A volume controller maintained constant wind rate on the furnace. It will be noted that with the top pressure maintained at 74 in. and at 40 in., that no reliable correlation between top pressure and pressure drop is possible. While it may be true that for a fixed voids condition, the resistance to gas flow will be lower at higher pressures than at lower pressures, unfortunately the flow voids channels in the blast furnace are continually changing, and in fact this change constitutes one of the most significant variables which affect the gas flow behavior. If by some magic method, the voids in the furnace could have been held absolutely fixed during the test period represented in Figure 4, then certainly the pressure drop with higher top pressure of 74 in. in the furnace would have been consistently lower than the pressure drop at the lower pressure value of 40 in. Experience with differential blowing indicates that any pressure drop reduction advantage to be obtained by merely increasing the top pressure to some maintained higher level by only about 1.5 or 2 psi is not by any means enough to compensate for or overcome the much greater effect on pressure drop of normal variations in the voids effective for flow. Modern furnaces may "stiffen" in their resistance to gas flow at rates up to 5 or 6 psi in a few minutes. The mere maintenance of only several psi of increased top pressure cannot overcome such increases; if the net increase in differential pressure and dust lifting power of the gases are high enough, then certainly hanging will result.

The reason for this inability to effectively prevent hanging, excessive channeling and slipping by merely raising the top pressure several psi can be visualized by referring to the variable orifice flow analogy mentioned previously. The effect of increasing the top pressure is to increase the gas density, so that for any instant or existing voids or orifice condition for given mass flow rates, the corresponding pressure drop will be lower than it would have been at a lower static pressure. As long as the orifice area is fixed, there will be a definite inverse relationship between the pressure drop of the flowing gas and the gas density. However, once the area of the variable orifice changes, as it continually does in the blast furnace, the new value of pressure drop corresponding to any given gas density must also take into consideration the new area of the orifice at the time. When it is recalled that a small change in orifice area will affect the pressure drop in a squared power relation in a variable flow metering device, while a change in density will affect it only in a linear relationship, one can appreciate that the effect of voids-variation in blast furnaces can be too great to overcome by methods to increase density as are now practiced. A ten per cent increase in absolute pressure (not gauge pressure), for example, will theoretically reduce the pressure drop through a fixed orifice, at given mass flow rate, by ten per cent. It requires theoretically only about a 5 per cent decrease in orifice area, or only approximately 2.5 per cent decrease in diameter of a circular orifice to nullify the effect of the pressure drop reduction advantage provided by increasing the absolute pressure 10 per cent. A 10 per cent change in effective orifice area for example, will change the pressure drop across an orifice by 21 per cent. (Any effects of changes in factor of approach on flow coefficients is neglected in these statements based on orifice metering analogy.)

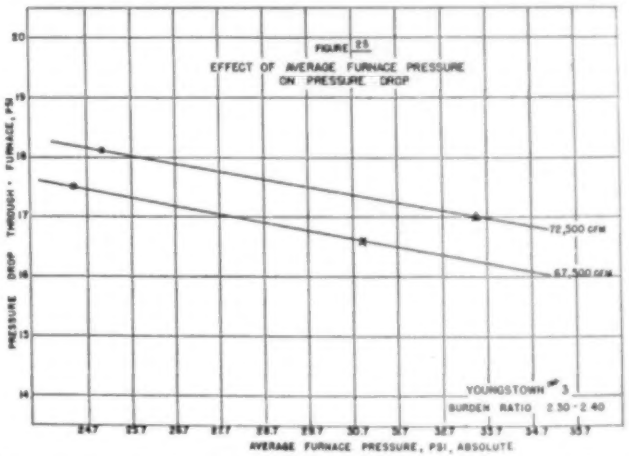


Figure 5 — Curve relates furnace pressure to pressure drop.

The same limitations which apply to the use of moderate top pressures also apply generally, but to a different degree to so-called high top pressure. In a report presented by J. H. Slater on "Operation of the Iron Blast Furnace at High Pressure," in the 1947 A.I.S.I. Yearbook, the curve reproduced in Figure 5 was shown. The curve relates furnace pressure to pressure drop and shows by its slope that an increase in average pressure of 7 psi will give a pressure reduction advantage of only 1 psi. Actually, the curve may be considered representative of only one voids condition; for other voids conditions it would be quite different. When it is considered that the range of daily pressure-drop variations may be as much as 4 to 6 psi or more, if the curve of Figure 5 is representative of typical high pressure operation, it can be appreciated that even with the maintained 8 or 10 psig high top pressure, the corrective action available may be insufficient to prevent hanging. To make matters worse, the high pressure method is still further handicapped if additional wind is added to the furnace, when it is realized that the pressure drop will be increased by roughly the square of the percentage of wind increase. For example, a 10 per cent wind rate increase should raise the pressure drop 21 per cent, or possibly at least 15 per cent.

The author has no quarrel with increased top pressure, on the contrary, it is felt that the use of differential blowing in conjunction with high pressure would

overcome the limitations of so called high pressure practice, about which there seems to be some doubt in the minds of many operators. It is not necessary to go to very high top pressures in order to maintain low gas velocities in the furnace. Regardless of the value of top pressure, be it high or low, if at the same time the pressure drop is high enough to hang the furnace, it will surely hang. It appears that by combining differential blowing with high pressure that furnaces which are now operating at 10 to 12 psi top pressure could blow the same wind and show as low a dust production at top pressures not exceeding 5 or 6 psi. At the lower top pressures, there would be much less maintenance and delay time. Further, not only would hanging be positively prevented, but more wind could be blown by the low pressure blowers, per unit pressure head after the blower, and at a steam cost comparable to that of low pressure blowing per blowing unit.

The differential blowing method is also adaptable for inter-locking control with temperature measurement of the hot blast and top gas temperature; it may also be used with humidity control of the blast.

DIFFERENTIAL PRESSURE RECORDS OBTAINED AT NEVILLE ISLAND

A study of the differential pressure records obtained on the furnace, and a comparison of such records with the controller mechanism both in the off and on positions throws some interesting light on the pressure drop changes under good and bad furnace working conditions, and before and during hanging and slipping. Figure 6 shows records of the relative changes in pressure drop through the furnace during bad and good days respectively. The record shown in Figure 6a was made during a day of operation when the furnace was hanging and slipping and during which the differential blowing controller was taken out of operation; the record of Figure 6b was taken with the differential blowing control system in operation, and with the furnace operating smoothly with no hanging or slipping.

With reference to the record of Figure 6a representing poor furnace conditions a cross mark (X) has been placed at every point at which there appeared to be hanging and slipping in the stock movement, as indicated by observation of other records and furnace conditions. At some points the slip occurred as the furnace wind was being checked. While some of the slips were of such severity as to cause the gas bleeders to open, others were less violent. It will be noted that preceding each major slip, there is a rise in differential pressure which reaches a peak, at which the record fluctuates as gases blow through, and finally the slip occurs, followed by a sudden pressure drop. It will be noted that the nature of the rise and fall during each cycle follows a similar patern, except for variations in wave amplitude and time-duration preceding the slip, which varies for each rise cycle. The wave width of each cycle is an indication of the time it takes for the furnace stock to tighten or increase in resistance during hanging, and before the slip occurs, this time may be as little as several minutes possibly, or a much longer time of many minutes.

There are many resistance-change cycles in Figure 6a, which, while they resemble those accompanied by visible slipping, were not of such severity as to be classed as slips; such movements may be classified as "slides," in many cases accompanied by jerky stock movement. It was also observed that the shape of the differential pressure wave cycle was determined by the rate of stock movement. The terms "slip" and "slide," therefore, actually differ only in magnitude or intensity. Although the smaller wave cycles may not be accompanied by complete hanging, there may be a slowing up of the furnace movement.

Just as the variations in differential pressure recorded in Figure 6a show the behavior during hanging and slipping, the variation may also indicate excessive channeling conditions by recording low differential pressures at normal wind rates. There is always a cer-

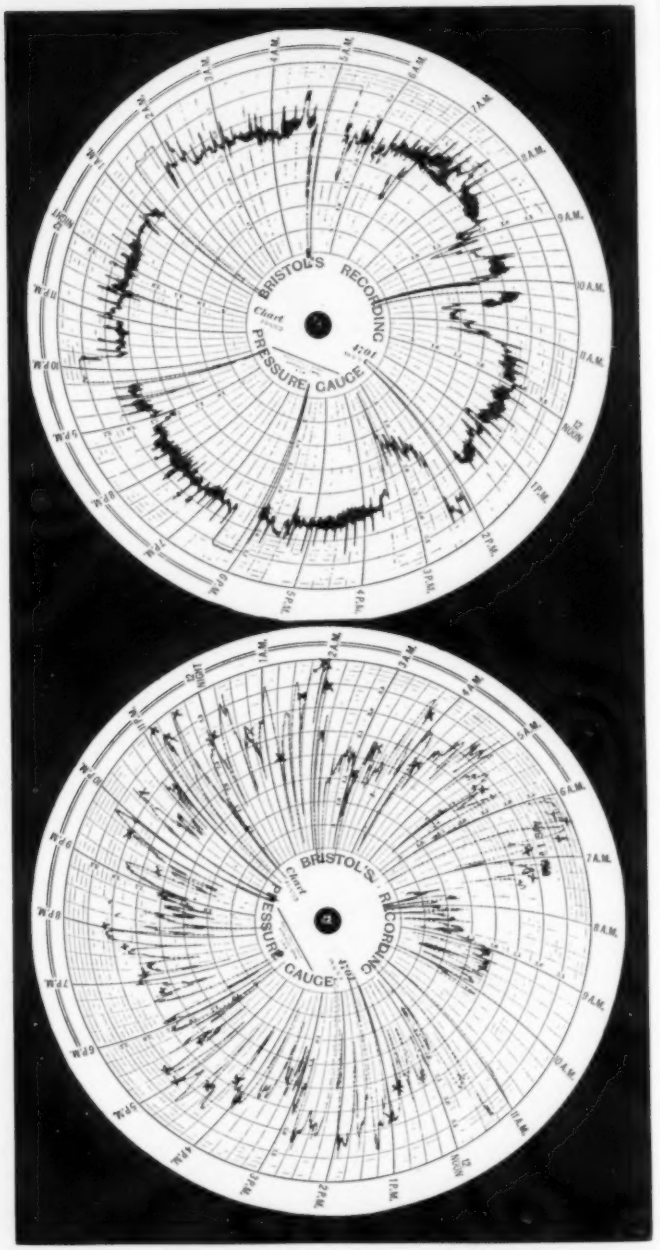


Figure 6 — Lower chart "a" gives a record of the pressure drop through the furnace on a bad day during a period when the differential blowing controller was taken out of operation; and chart "b" was taken during a day with the blower in operation. No hanging or slipping is noticed in chart "b" (upper chart).

tain amount of channeling present in all furnace operations and the furnace operator must settle for some arbitrary amount of channeling.

With the use of differential blowing on the furnace, the materials in the charge and the gas flow streams tend to adjust themselves to the controller settings. The differential blowing system can be set to "force" the burden to assume a low voids condition or a very open voids condition. By the use of the differential blowing control system to provide a record similar to that of Figure 6b, not only can hanging and slipping be prevented, but excessive channeling can be kept at an absolute minimum by better equalization of the gas flow distribution.

All of the complete hanging which accompanied the differential pressure cycles is represented by X-marks in Figure 6a. The chart does not indicate the actual differential pressure but only relative changes. The pen travel across the chart range is equivalent to four psi differential. The average pen position on the chart during a slip was at 2.71 on the chart; the highest pressure drop at which the slip occurred was at 3.9 on the chart; the lowest at 1.6. The difference between these two extremes is 2.3 psi. Merely by maintaining the top pressure at some high level of, as for example, 1 to 2 psi higher than normal for the day represented by the record, would certainly not have prevented the furnace from hanging; this will be realized from what has been said with reference to Figure 4. The only way to further reduce the gas velocities through this furnace was by reducing the wind rate. By combining the reduced pressure effects resulting from top pressure control and wind volume control, if on the day represented by Figure 6a, the differential pressure pen had not exceeded a differential pressure represented by the 1.6 psi reading on the chart, no hanging and slipping of the furnace would have occurred.

The amount of wind reduction necessary to keep a furnace from hanging will depend upon the tendency for the furnace resistance to increase or decrease, as well as on the range of top pressure that may be used to counteract hanging tendencies. As stated before, by modulating the top pressure in response to changes in differential pressure, as opposed to maintaining a fixed top pressure, not only can the top pressure be used more effectively, but less wind reduction will be necessary to prevent hanging. With this type of operation, it is just as necessary to reduce the top pressure as the furnace resistance eases to gas flow, as to increase the top pressure to counteract increased resistance to gas flow. By modulating the top pressure levels to lower values as the furnace eases, and instantly and continuously as the differential pressure tries to change, considerably greater control effectiveness is available. With the top pressure resting at some lower value as the furnace tries to stiffen, there will still be available the difference between the existing top pressure and the maximum safe permissible top pressure with which to counteract the tendency toward stiffening. With the alternate method of maintaining the higher top pressure at a fixed level, not only will much control effectiveness be lost, but by the resulting higher average pressure that will exist on the furnace, it will cost more for steam to blow the same volume of wind through the furnace, as well as to require more wind reduction to prevent hanging.

OPERATING RESULTS WITH THE DIFFERENTIAL CONTROL SYSTEM

Depending upon the manner in which the control system is operated, it may be used as a relief to alleviate the severity of slips after they occur or, it may be used to prevent hanging before the slip occurs. Since the installation of the control system at Neville Island, gas bleeder valve opening as the result of furnace slip-

Figure 7 — Chart of stockline movements shows slips which occurred on furnace during a day when the differential blowing control was both operating and not operating.

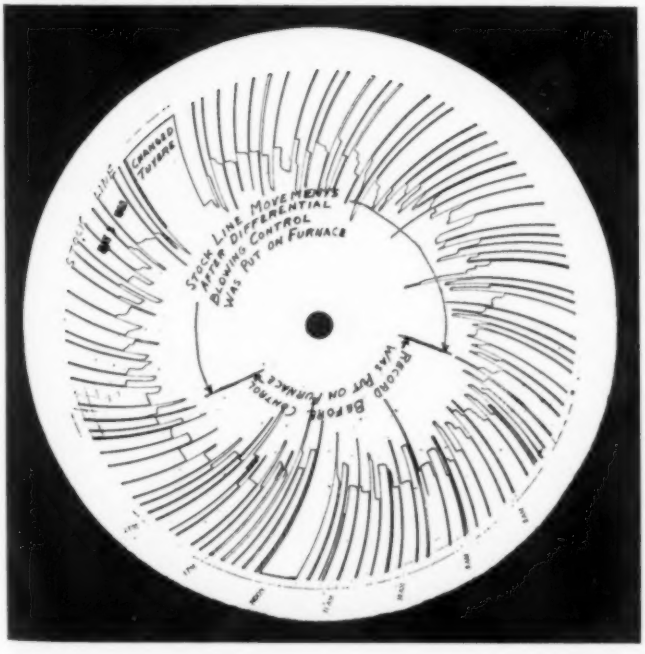


Figure 8 — Chart record from 4:00 pm to 7:00 pm for top pressure shows smoother operation after differential blowing control was put on furnace.

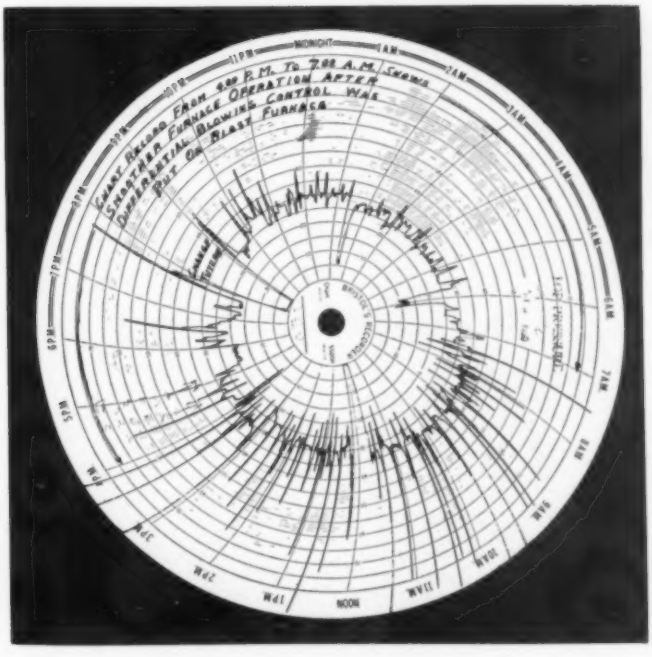


CHART RECORD FROM 3:00 P.M. TO 7:00 A.M. SHOWS SMOOTHER FURNACE OPERATION AFTER DIFFERENTIAL BLOWING CONTROL WAS PUT ON BLAST FURNACE

ping has been practically eliminated, with the result that the blowers do not have the worry about pulling the snort wheel as they used to. Dusting has been greatly reduced, although as stated before, no attempt was made to determine quantitatively the exact reduction.

The fast effectiveness of the pressure drop control method can best be shown graphically by reference to the "before" and "after" records in Figure 7 and 8, which show the records of slips on the top pressure chart and the corresponding stockline chart respectively. The furnace had been continually hanging and slipping for weeks. Any long-time changes such as burden changes, extra coke blanks, scrap charges, or other measures seemed to have no effect on the furnace. The chart records from 7:00 am to 4:00 pm show the typical behavior of the furnace during these weeks with the differential pressure controller not on the furnace. At 4:00 pm the differential pressure controller was put on the furnace to operate the relief blast control valves. Within a short time, the furnace moved off. As shown by the chart the stock movement was good for the rest of the day until 7:00 am the next morning. The furnace continued to operate in this manner for several weeks, when it was decided to take it off the furnace to see if the operation would continue as smoothly without the controller. Before the first day passed, the furnace went back to hanging and slipping, with the result that the daily number of charges taken was again reduced; by the end of the second day it was decided to put the controller back on the furnace. Improvement in the results were again apparent after a few hours of operation with the controller on, which indicated that it was the differential pressure controller which was responsible for the improved operation, and not any changes in coke or scrap charged. A very high coke rate was used but it did not seem to do much good. When the furnace went down for repairs several weeks later, a scaffold was found on the furnace side opposite the skip hoist lo-

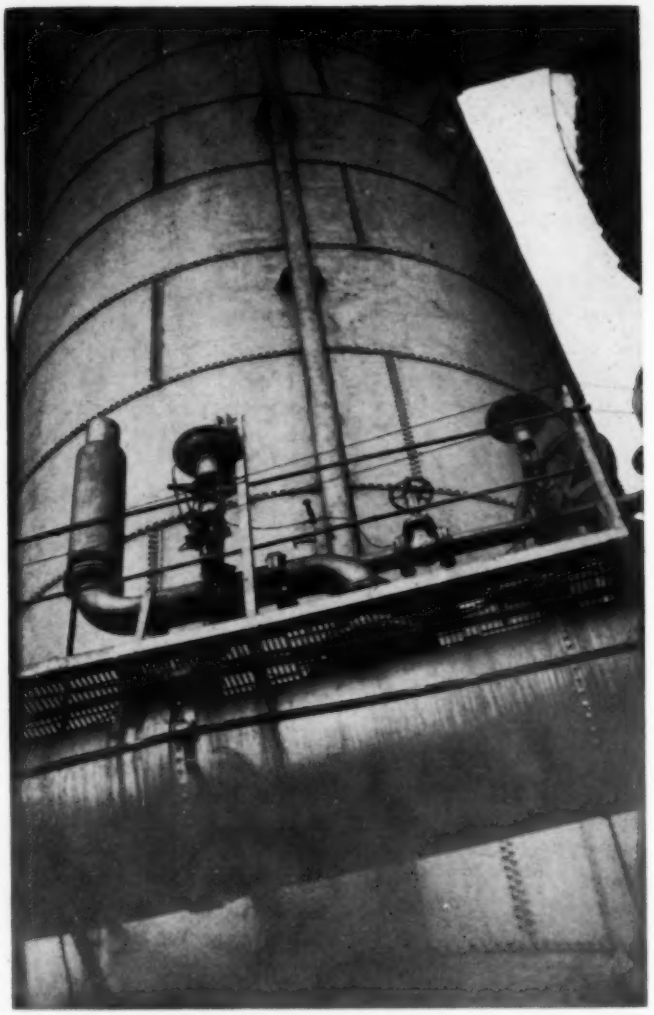


Figure 10 — Air blast relief valves in the cold blast main bleeds wind to the atmosphere.

cated about two thirds of the distance from the mantle to the stockline; it was of a hard, shiny appearance and extended about six feet into the furnace. It is surprising that the controller was able to be of any benefit under these difficult conditions.

While no attempt was made to keep a close check and record of the furnace practice during this period, a comparison of the data taken from the log sheets for two weeks preceding the starting up of the differential pressure controller, and for the two weeks after it was put in operation, showed that the average number of charges put into the furnace increased from 88 per day for the period without control, to 98 per day average, with a high of 104 charges per day, during the period with control on the furnace. In addition, the period for controlled differential pressure showed an increase of over 8 per cent in iron tonnage produced. It is believed that small changes in practice did not account for this improvement, as was shown by taking the controller off for two days.

During the uncontrolled period and all of the controlled period except for a little more than a day at the end of the controlled period, the blast rate was the same. At the end of the two weeks of operation with automatic control the blast was increased 1000 cfm. It is interesting to note that despite the fact that the blast volume put through the furnace during the controlled

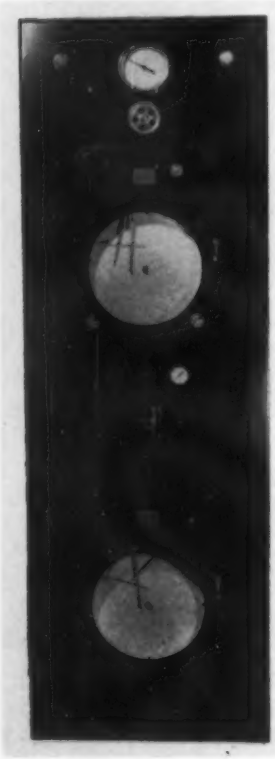


Figure 9 — The main controllers with manual-automatic stations and interlock devices are mounted on a control panel which is electrically and pneumatically operated.

period was actually less than during the uncontrolled period because of the air bled to atmosphere, the tonnage produced during the controlled period was increased more than 8 per cent; undoubtedly the gas-solid contact must have been poor without control, and must have been improved with it. Whether the same increase in wind efficiency would have resulted in a good furnace not having a scaffold condition could not be determined without further trial operations.

Figure 9 shows the control panel, on which are mounted the main controllers with manual-automatic stations and interlock devices. The particular panel shown is electrically and pneumatically operated. The recorder-controllers shown are piped to pressure taps located in the blast main to the furnace, and in the gas main leaving the furnace or, alternately, the taps may be connected to measure pressures at two successive elevations in the furnace stack proper. The control panel incorporates means for setting the ranges for control of the difference in pressures between the tap locations and of the top pressure control, and for interlocking the control actions of the two recorder-controllers.

Figure 11 — A 36-in. power operated gas control butterfly valve is located in the 72-in. gas main after the wet gas washer.

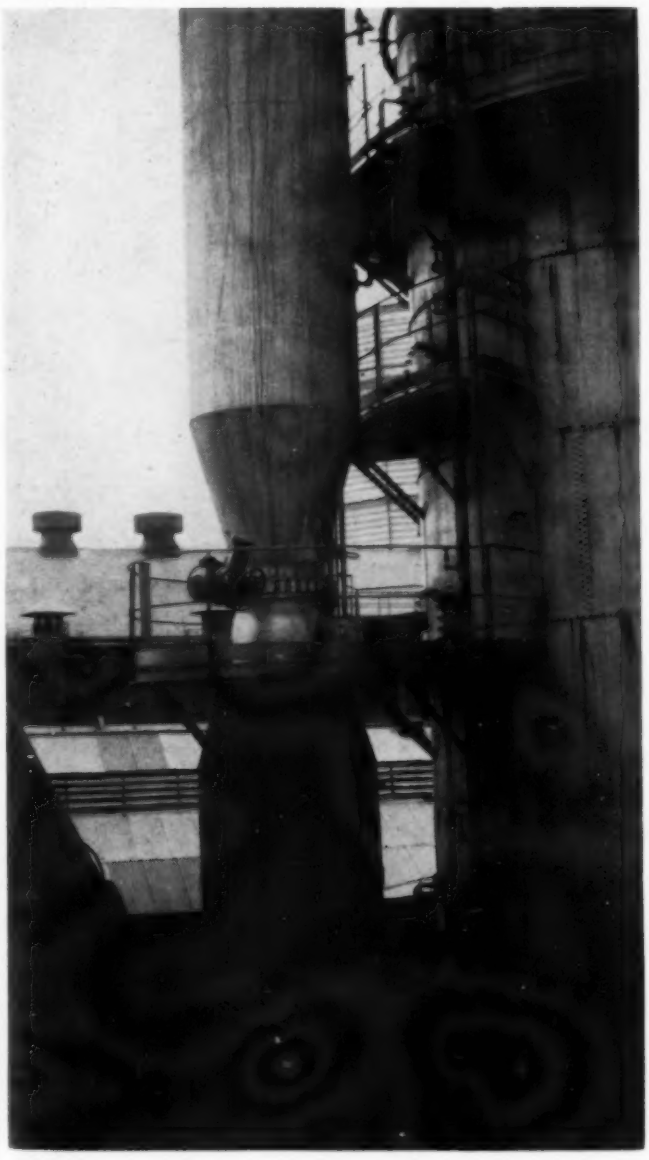


Figure 10 shows a view of the air blast relief valves which bleed wind from the cold blast main to atmosphere. The smaller valve shown is a 4 in. modulating valve; the large valve is an 8 in. quick-opening valve. A noise silencer is also shown connected to the outlet from the 8 in. relief valve.

Figure 11 shows a view of 36 in. power operated gas control butterfly valve that is located in the 72 in. gas main immediately after the wet gas washer. The butterfly valve is located in the smallest area section of the venturi-shaped reducer in the gas line.

CONCLUSIONS

Results from the operation of the differential blowing system to date at Neville Island have proved that not only can trends in furnace irregularities that may result in channeling, hanging, and slipping be pre-determined by measurement methods, but that by taking proper control steps in time, hanging and slipping can be reduced or even prevented, depending upon the degree of controllability that is made available. The method of control has helped to solve an air pollution problem, and it has paid for itself by improving the smooth operation of the blast furnace, with decreased dust production and increased hot metal output. It is hoped that further operations with differential blowing will make it possible to better evaluate the results.

ACKNOWLEDGEMENT

The author wishes to express sincere appreciation to various men of the Pittsburgh Coke & Chemical Co. who co-operated in the testing of the differential blowing method. These include Mr. G. D. Dignan, Mr. R. M. Marshall, and the late J. R. Comstock all of whom offered encouragement and made the trial operation possible; Mr. W. H. Thomas, Mr. Ben Williams and Mr. L. W. Adams, Jr. who co-operated wholeheartedly; Mr. B. H. Hughes who was quite helpful with the field work.

ADDITIONAL DATA ON CONTINUED OPERATIONS OF DIFFERENTIAL BLOWING CONTROL

At the time that the original results obtained by the use of differential blowing at Neville Island were reported, the method had not yet been tried sufficiently to make it possible to give a complete report. The system was put into full operation during the winter of 1951. The operating results from this test were presented in a paper titled "Operating With Leones' Differential Pressure Control at Neville Island Blast Furnace," by Mr. L. W. Adams, Jr., which was delivered before an A.I.M.E. meeting held in Pittsburgh, Pa. on March 31, 1952.

Figures 12 and 13, which are taken from Mr. Adams' paper summarize the operating results at Neville Island before and after differential blowing was installed. It will be noted that with differential blowing there was substantial improvement in the furnace operation, with increased wind blown, increased hot metal output, reduced dust production, and reduced bleeder operation.

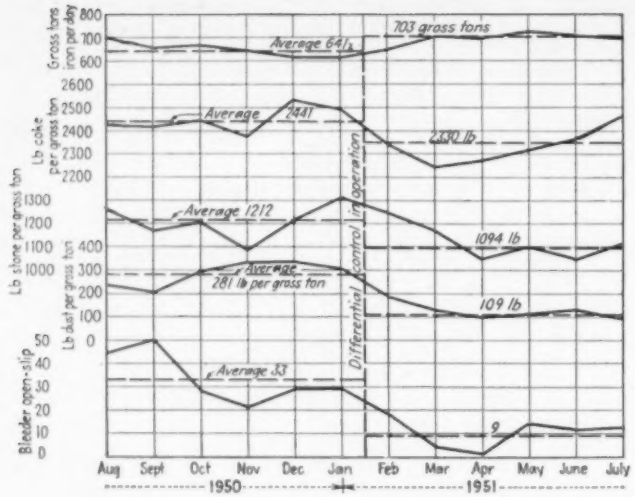


Figure 12 — Operating data at Neville Island blast furnace with differential pressure control.

Figure 14 has been drawn by the author for the same period covered by Mr. Adams' paper and includes other operating results in addition to those covered by the paper. It will be noted from curves 2 and 4, that despite the fact that the furnace operated at higher top pressures during the controlled period which at times was almost 2 psi higher than the average top pressure before the controlled period, the work of compressing the air blast was easier for the turbine during the controlled period. It will also be noted that during the controlled period, the average blast pressure was only ½ psi higher than without control, in spite of the fact that substantially more wind was blown against higher average top pressure during the controlled period.

Curve 5 of Figure 14 shows dust production on the basis of wind blown instead of a per ton of iron basis. It is interesting to note that the dust produced during the controlled period compares favorably with dust figures reported for high pressure operation, in fact the figure of 1506 lb of dust per day per thousand cfm of wind blown is lower than dust production reported for most furnaces operating on high pressure.

It will also be noted from Figure 14 that the average operating hot blast temperature was increased 63 F during the control period with differential blowing, and with the increased wind rate on the furnace.

Figure 13 — Table, reproduced from paper by L. W. Adams, Jr., tabulates operating results on blast furnace before and after use of differential control.

TABLE I—*Production at Neville Furnace*

Date	Daily Avg Gross Tons	Pounds per Gross Ton Iron			Wind Avg, Cfm	Avg Silicon, Pct
		Coke	Scrap	Flue Dust		
Furnace Blown in July 15, 1950						
Aug.	648	2,428	158	237	55,429	2.34
Sept.	651	2,419	65	202	55,746	2.39
Oct.	666	2,485	23	294	56,918	2.38
Nov.	647	2,377	33	335	53,313	2.40
Dec.	617	2,532	10	336	52,903	2.24
Jan.	615	2,495	15	303	54,059	1.60[a]
Avg	641	2,456	51	285	54,728	2.23
Differential Control on February 15, 1951						
Feb.	644	2,349	19	186	55,356	1.71[a]
Mar.	700	2,246	154	121	57,073	1.76[a]
Apr.	693	2,270	149	92	58,387	2.22
May	723	2,315	154	109	59,972	2.22
June	709	2,356	153	130	59,505	2.08
July	692	2,453	167	96	59,033	2.17
Aug.	682	2,396	117	159	59,054	2.21
Avg	692	2,341	130	128	58,340	2.05

[a] 40 to 50 pct basic iron produced during January, February, and March.

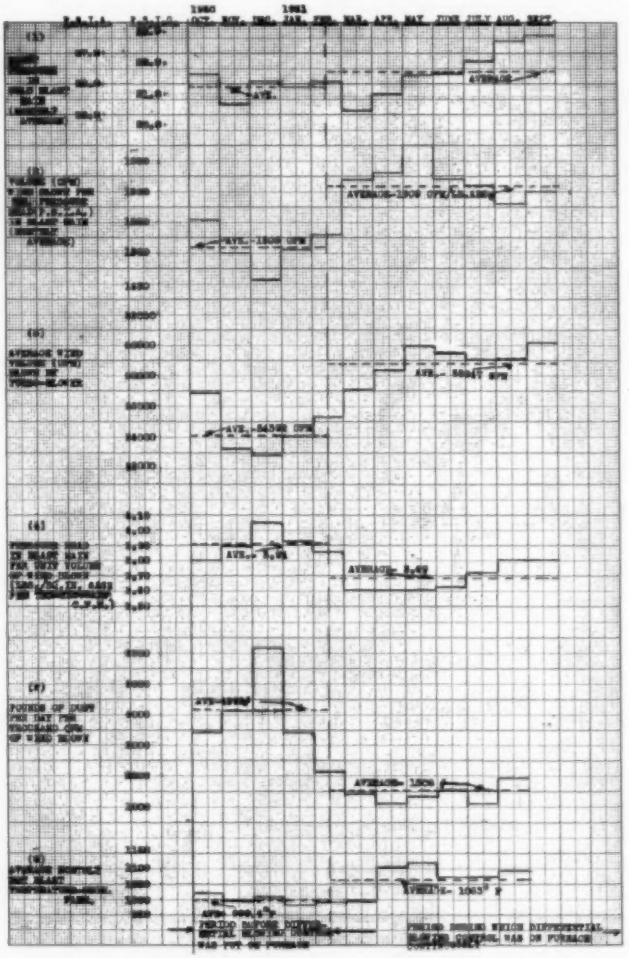


Figure 14 — Additional operating data for the Neville Island furnace are given in these charts.

In the original differential blowing operation at the Neville Island furnaces, the reduction of wind volume was done by modulating the 4 in. air blast relief valve located in the cold blast main; later, the reduction in wind volume was accomplished by inter-locking the action of the constant-volume governor control with the differential control panel, so as to save steam.

In the original trials reported for Neville Island, it will be noted that with a scaffold furnace, an increase in tonnage was shown with differential blowing, in spite of the fact that less wind was put through the furnace

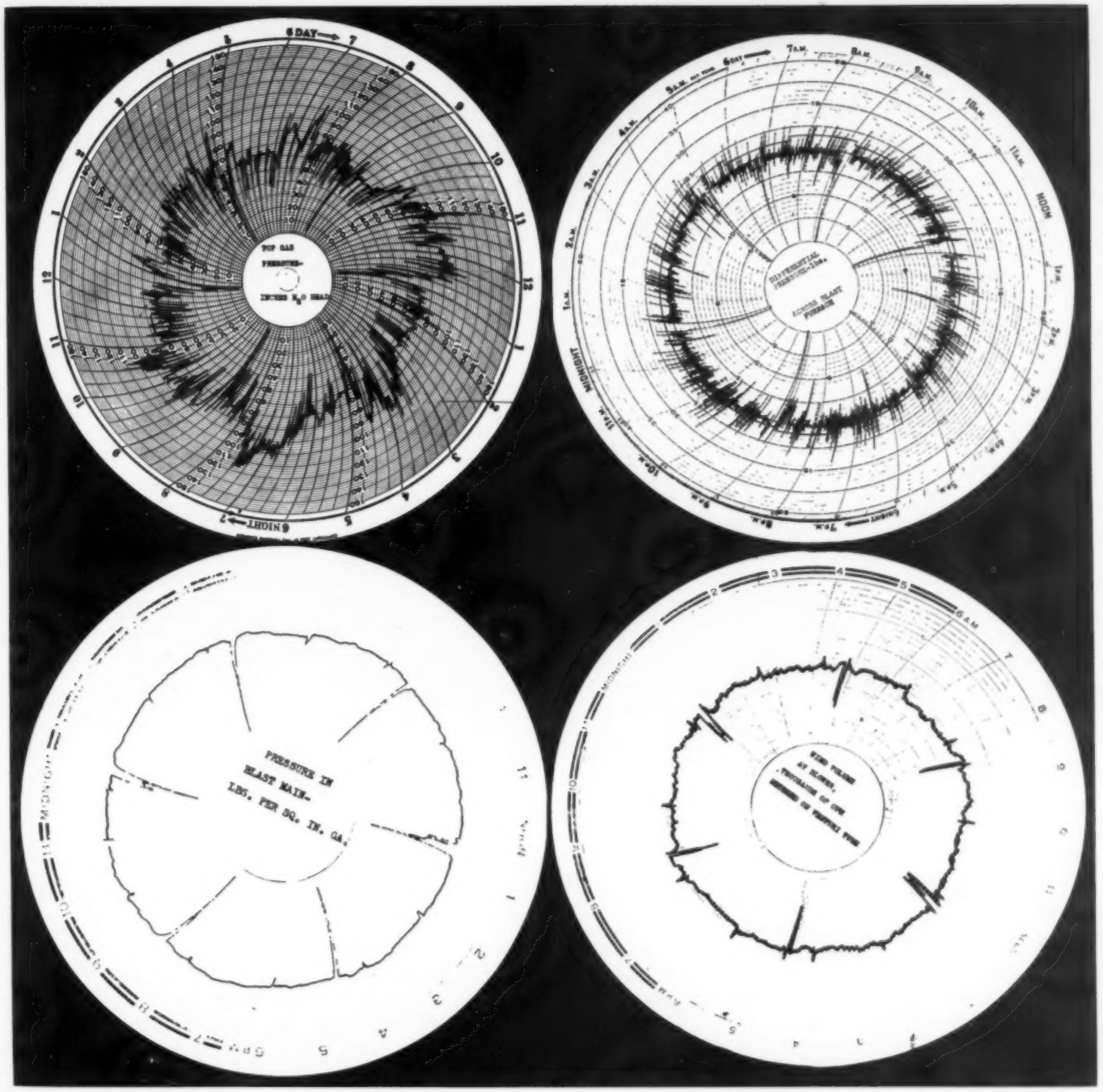


Figure 15 — Charts show operating records from the differential blowing system installed on the blast furnace at Alan Wood.

as the result of bleeding it to atmosphere. With further operation after the furnace was relined and in better condition, the operators concluded after some operation by bleeding wind alone to control pressure drop, that the tonnage suffered if the net wind put through a good working furnace was reduced. They were reluctant therefore to control by bleeding blast only, and seemed to prefer to tie in the top pressure control with it in order to keep wind reduction to a minimum. It would seem, therefore, if the operators were correct in their contentions, that in spite of the reduction in net wind put through the furnace when it was scaffolded prior to the relining, the reason it was possible to show improvement was that the furnace was in very bad shape at the time.

OTHER INSTALLATIONS OF DIFFERENTIAL BLOWING SYSTEMS

Since the original Neville Island trial of differential blowing, arrangements have been completed for the installation of the method to three other furnaces. One of these is at the No. 2 blast furnace at the Monessen Works of Pittsburgh Steel Co., which installation was started during the summer of 1952. Another installation was made on No. 2 furnace at Alan Wood Steel Co., at Swedeland, Pa. which was put into operation in June 1952. The most recent installation is now being made to the new "B" furnace at Neville Island.

The trial periods at Alan Wood Steel Co. and at Pittsburgh Steel Co. are not yet complete. They do

show, however, that it is possible to prevent hanging and slipping by the use of differential blowing, to reduce dust production, and to increase tonnage output.

Chart records taken from the Alan Wood installation are reproduced in Figure 15. The wind rate recorded in Figure 15 at the time the chart was made was in excess of 10 per cent higher than the average wind rate which was reported before differential blowing was installed. These charts are representative of good practice in differential blowing, and show how the top pressures may purposely be varied to good advantage, by increasing them to combat increasing resistance to gas flow in the furnace, and by decreasing the top pressure to new low reference levels as the furnace resistance tends to ease; as soon as the furnace again tries to stiffen to gas flow. By having the top pressure at the lowest possible level, the operator has available more top pressure to "play" with to combat further attempts for the furnace to stiffen; at the same time this type of operation will call for much less wind reduction to keep the furnace from hanging than would otherwise be necessary. In addition, the blast pressure corresponding to the existing furnace conditions will be an absolute minimum, and much lower for the same wind rate than if the top pressure had been controlled to a constant high value and the pressure drop controlled on the blast pressure side of the furnace. The average blast pressure recorded in Figure 15 did not seem to be any higher than it had been before the differential blowing system was started, despite the fact that with differential blowing for the day being recorded, the wind rate shown is substantially higher than the maximum wind which this furnace had been carrying just prior to the starting of the differential blowing, and despite the fact that the top pressures with differential blowing are as much as several pounds higher than they were before control. This confirms the results at Neville Island as shown in curves 2 and 4 of Figure 14 of this paper. It will be noted that there are two records on the differential chart of Figure 15, one of which appears to be almost a perfect straight line; the sum of the two records is an indication of the actual pressure drop being controlled at any time. Experience with differential blowing has shown, that for any furnace, if the controlled pressure drop does not exceed some value that is easily determined for the particular furnace, it is practically impossible to hang the furnace. The furnace does not immediately hang if this value is exceeded, but every time the furnace does hang this value will have been exceeded. It is not necessary to know the exact value to keep the furnace from hanging. Because the wind being carried on the furnace at the time that the charts in Figure 15 were recorded was substantially higher than normal, if the index settings represented in the charts had purposely been set high, the operator could have hung the furnace very easily within a few minutes. By having the indexes set properly, to maintain proper values of pressure drop, however, as long as there was something to control on the furnace to keep the control action alive, it has been possible to keep blast furnaces from hanging for as long as 10 to 12 weeks or more at a time.

According to latest reports, the increase in wind rate and tonnage is not quite as good as that originally reported. It must be said, however, that the production on this furnace based on tons per sq ft of hearth area was always very high, which fact would make it more difficult to show the same percentage increase on the furnace as on a poorer furnace. Final operating results have not been tabulated by the operator, according to last reports.

The installation at No. 2 furnace of the Pittsburgh Steel Co., at Monessen, Pa. started off well, but after several months of operation, trouble was being experienced with the opening of the big bell when the modulated top pressure reached values of 60 to 70 in. of water. An equalizer valve is now being installed to correct this difficulty. Immediate improvement was also seen with this installation, especially, in preventing hanging and in increasing hot metal produced. It is interesting to note that the wind rate on this furnace was immediately increased by an amount which the author estimates to be in excess of 10 per cent, and with a substantial increase in iron output. The furnace operated for as long as three months without accidental hanging, whereas, before differential blowing was used, it hung often. Because of the lack of sufficient blower capacity, it has not been possible to determine the maximum increase in wind rate that may be possible on No. 2 furnace with differential blowing. Until the time that trouble was experienced in opening the big bell, in addition to the maximum wind that the blowing engines could blow, up to 3 or 4 thousand cfm of additional wind was diverted from a modern turbo-blower on No. 3 furnace to No. 2 furnace by means of a form of split-blowing practice. It appeared at times that the furnace could take more wind than was available. With the installation of a new turbo-blower now completed for No. 2 furnace, as soon as the equalizing valve installation is completed to overcome the large bell trouble, it will be possible to properly test differential blowing on the No. 2 furnace.

It is hoped that the operators of the latest installations will permit the results from their installations of differential blowing to be reported when tabulations are completed.

Differential blowing has now been tested on both merchant and basic types of furnaces. One of the three installations now running has made little basic; at a second plant the furnace has made both basic and hotter iron; at the third plant the practice is all basic. It appears from observations to date that basic furnaces should be easier to control than those working on hotter iron.

In concluding this report it can be said that the results to be obtained from the use of differential blowing appears to be very promising. If the furnace operators will make the control means available to completely counteract all tendencies of the furnace toward hanging, it is possible to prevent hanging in the furnace. The results of properly practicing differential blowing are positive and not of a statistical nature; whether or not a furnace will hang need no longer depend upon the elements of chance and probability, because the furnace behavior in this respect can be controlled.

IDENTIFICATION MARKING OF BLOOMS, BILLETS AND SLABS

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. . . . identification of the steel being processed is essential in steel plant operations . . . .

▲ THE subject of this discussion has to do with the practices of marking blooms, billets, and slabs for identification commonly used in the steel industry in the United States. It seems fitting at the outset to review two questions which the subject may inspire.

What is meant by identification in this context?

Why is such identification necessary?

The answers to these questions provide the chief reasons for identification marking. The particular marking practices in use in each mill have been developed in accord with the details of these reasons as they relate to its products and to its facilities and operating conditions.

The terms blooms, billets, and slabs are names for general classes of semi-finished steel based on size and shape. All are produced in the first rolling and shearing operations performed on ingots; and each is intended for further processing to prepare the steel for its ultimate use. Because of this similarity among them it will be convenient to refer to any of them as a "piece," except in particular references where a detail of the practice may be limited to one class only.

Each piece is an individual article, not precisely the same as any other. Its uniqueness is due to certain characteristics: composition of the metal, dimensions and weight, and intended purpose. In order to distinguish one piece from another, all of these characteristics must be known and described in a form which can be expressed in terms capable of being communicated to all who have an interest in the identity.

The subsequent processing of the piece requires that there must be sufficient information about each characteristic to assure the suitability of the piece. All of this information already has been accumulated in records at the time the piece is cut from the original hot rolled section, since this has been necessary in order to produce the piece for its particular intended use. The physical application of these terms to any piece is called its identification.

The earliest distinction among the hot semi-finished pieces is actually the position in the time sequence in which they are produced. This time distinction is converted into a physical distinction among the pieces, while they are still hot, by so spacing them that the location itself is the immediate temporary identification. This location may be on a cooling bed, on a piler, in a buggy or truck, in a pile on the ground, or it may be a position in a series of pieces moving on a roller table, conveyor, or transfer. Thus, location is the only identification at first.

However, semi-finished steel is destined for subsequent handling and processing; the first location is not the last. To use each new location as the continuing means of identification would require a ponderous system of record keeping and vigilance in watching the steel as it is moved from place to place.

Observation of the steel itself discloses that its appearance alone does not reveal the identifying characteristics adequately. The composition of the metal is not apparent; generally it all looks alike. The dimensions and weight can be estimated, but not with an accuracy required for many operations. The intended purpose may or may not be deduced from the dimensions. It can be inferred that errors might occur in a practice using a method of location as the sole means of permanent identification.

It will be understood that any error in identification is attended by a subsequent cost; a cost which may be determinable in money in the manufacturing operations or which may be of a somewhat intangible nature, but a real cost nevertheless. This kind of cost is a measure of one of the risks of producing semi-finished steel, and the recognition of this risk is the origin of steel identification practices.

All these practices have been developed as an assurance against this kind of risk which varies over a rather wide range depending on the subsequent manufacturing processes and on the ultimate use of the steel. The probable cost of the risk is the economic upper limit of the identifying practice expense which the manufacturing cost can bear. Thus in operations with a small risk, these practices are simple and inexpensive; conversely, in operations involving a large measure of risk from identification errors the practices are quite elaborate.

While the fundamental necessity for identification is seen to be assurance against a certain type of risk, the characteristics to be identified are responsible for two different kinds of need. The first is the absolute need to identify the composition of the metal, since the only other means is a laboratory examination of a sample taken from the piece. The second is more as a convenience, for otherwise any piece could be measured or weighed accurately, and the intended purpose could be discovered by searching through production records.

MARKING SYSTEM

Rolling mill operating experience has demonstrated that a system of marking is the most practical means of providing identification, and because of the variety of characteristics which must be identified plus the desirability of having the least number of marks for one piece, the usual system is an arrangement of symbols in a code form.

Symbols — Certain qualities in the symbols are preferred in order that they may be used readily and accurately. The symbols must be:

1. Capable of being understood exactly by everyone required to use them;
2. Reproducible by any one who has to perform the marking;
3. Suited to oral, script, or typed forms of communication.

These qualities tend to prevent the use of any symbols except Arabic numerals, Latin letters, and a few conventional signs. The letters are the capitals, except I, J, and O which are omitted to avoid confusion with the numerals 1 and 0.

Code — The code includes a designation for every kind of identification required by the processes in the plant. It may identify only one characteristic: the composition of the metal; or it may embrace size, weight, and intended purpose as well.

The most important designation is that which identifies the composition of the metal. This composition is the consequence of one incident: the melting and solidifying of one batch of steel, the "heat." The individuality of the heat has been recognized for so long in so many operations that it is common practice for each heat to have an identification. This is called a "heat number" in open hearth and electric furnace practice, and a "blow number" in bessemer practice. For convenience in this discussion, the term heat number refers to both. It is used almost universally as the principal identification for every piece of semi-finished steel produced from that heat.

The usual enumerating systems employ heat numbers consisting of two parts. One part identified the furnace. This may be numerals only or may be numerals and letters, the latter where it is necessary to distinguish between like numbered furnaces of different kinds such as open hearth and electric. A second part represents the number of consecutive heats tapped from that furnace since some arbitrarily selected date or occurrence. It is usually either a 3-digit or 4-digit number. The combination of the number of the furnace and the consecutive number of the heat produces a heat number of at least 4 characters and as many as 7. As an example, heat number 1234 may represent the 234th heat from No. 1 open hearth furnace, and heat number 12X3456 the 3456th heat from No. 12 electric furnace.

A limited range of the values for the several factors which determine the composition of the metal is regarded as a "grade" of steel. In many operations it is commonly the practice to add to the heat number, either as extra symbols or as supplementary symbols, a designation which identifies the grade. In some operations, using only a few grades, a color code for grade is employed.

The size of the piece is conceived first in its cross-sectional dimensions measured in inches and the fractions: halves, quarters, eighths; and for small billets even sixteenths. A secondary concept includes length or weight. Length is thought of in inches and fractions up to a maximum of about 240 inches; longer lengths in feet and inches. Weight is always conceived as a number of pounds. The sign X is used to relate any two dimensional figures. The sign # following a number sometimes is used to represent "pounds"; sometimes the abbreviation lbs is used; frequently where the meaning is clear both are omitted. The sign " for inches is omitted except for lengths expressed in both feet and inches where it is used in conjunction with the sign ' for feet.

The intended purpose may be included in or indicated by the grade designation. It may be represented by an abbreviation for the name of the next following depart-

ment or operation, or for the name of the customer or the customer's plant, or by a more specific designation; for example, an order number.

Almost all the semi-finished products are identified by codes which include some of these features. In addition, there is a substantial tonnage which requires a means of distinguishing parts of heats, parts of ingots, individual pieces, and even in extreme cases, of identifying the metal in the piece to its former position in the ingot.

It is not unusual that the top cuts from ingots of certain ordinary plain carbon heats are separated from all other product of those heats. The top cut pieces are distinguished from the main portion of the heat by adding to the heat number identification a suitable letter designation, such as a capital T. This is separated from the heat number in marking and is usually made of a larger size than the characters in the heat number. A few practices require that the cuts from the ingots be separated into a number of groups representing various sections of the ingots, such as tops, middles, and bottoms to as many as five sections. It is customary to use an identifying system similar to that for top cuts, and a series of letters is adopted: T for tops, C, D, E for separate middle groups, and B for bottoms.

Certain special grades of carbon steel and many alloy grades require that the ingots in each heat be identified in sequence of pouring. The ingots are designated 1, 2, 3, — N and the product of each ingot is marked with its appropriate ingot number in addition to the heat number. As in the lettering system these ingot numbers are usually made larger and separated from the heat number.

A further refinement for certain grades, mostly alloy, requires that each piece from each ingot be identified in its position in the ingot. This is done by using a series of numbers or letters indicating progressive cuts from the top, occasionally from the bottom, of the ingot. The marking is carried out in the same manner as for top cuts or ingot numbers, but in this case, each piece has three symbols necessary for identification: heat number, ingot number, and cut letter or number.

The present limit of this kind of identification appears to be reached in a very special case of certain alloy grades subject to rather searching examination and produced in relatively large sizes of semi-finished pieces. It is the necessity to identify which end of the piece was up when the ingot was poured. Additional symbols for this purpose are avoided by adopting a practice of always marking one of the other symbols, usually the heat number, at the same end of the piece. The location of the number in this way identifies the position of the metal in the piece as poured.

Identification Marks — Certain preferable features are desired in the identification marks in order that they may serve the needs of the several operations to which the semi-finished steel is subjected.

The primary requirement is that the marks shall be legible. The size of the symbols should be large enough to be read by the average person from the usual distance of making such observation. The outline of each symbol should be complete and distinct to avoid errors in misreading.

The second requirement is that the marks shall be durable for the expected time period. They should not fade out, burn off, wash off, run out, or smear under the prevailing conditions of handling the steel. The surfaces on which the marks are made should not flake or rust enough to deface the symbols.

A third requirement is of a rather special nature: if the marks are stamped or pressed into the surface of the steel, they should not be such as to result in surface imperfections in the product of succeeding operations.

The marks must be made on something: on the steel itself, on objects fastened to the steel, on or attached to buggies, trucks, cars, cradles, or other containers, or on signs so placed with reference to the steel that the intent is unquestionable.

The manner in which the pieces are moved from place to place, or are loaded for shipment, and more especially the manner of piling the steel for cooling or for storage determine the preferred location of the identifying marks on the pieces. This location should be that which permits the easiest reading from a standing position on the ground at a safe distance from the pile.

MARKING METHODS

The methods of marking embraced in this discussion are those commonly in use in the steel industry, in the series of operations which begin with the creation of the semi-finished piece at the time it is cut from the original hot rolled section.

At the time the piece is cut, the surface temperature usually is in the range of 1600 to 1900 F, and, depending on the cross-section of the piece and the method of cooling and piling, it requires from about 1½ to 12 hours in the open for the surface to cool sufficiently to permit being marked permanently by chalk, paint or crayon. If, for some reason, permanent marking is required before this time has elapsed, it must be done by stamping the hot steel with dies. In most mills this stamping must be done at the rate the pieces are produced by the shear or saw; which, for very large blooms and slabs, may be as slow as one piece per minute; whereas, for small billets, it may be as fast as one piece every five seconds.

These factors of temperature, production rate, and size plus the particular operating facilities and working space in the area determine physically the limits of what can be done in methods of marking hot steel. In contrast, there are a number of methods of marking cold steel. Whatever methods are used, the choice depends largely on the needs of the subsequent processes, on the operating conditions and facilities in the rolling mills and in the steel yards, and on the cost.

The marking of cold steel at atmospheric temperature or warm steel at temperatures up to about 400 F constitutes the major amount of identification effort as measured by the number of marks made on the steel. It is performed by hand work, chiefly in the form of printing.

Hand printing with chalk, paint, or crayon — Light colors such as white, buff, and yellow are commonly used for the code symbols to provide the best contrast against the background dark grey color of the scale on the steel surface. The colors used in steel grade codes are white, and bright shades of yellow, green, blue, and red; again in order to provide contrast, especially when painted in stripe or patch combinations.

Chalk is probably the easiest medium to use. The soft variety marks plainly on any surface but its durability is rather brief. The hard variety marks well on smooth surfaces, but the width of the lines is quite narrow, and the symbols become difficult to see in a short time if the steel is stored in a dusty or dirty location. On rough surfaces, hard chalk tends to mark only the high spots and may produce indistinct symbols. For these reasons the use of chalk is restricted generally to preliminary marking as a temporary expedient.

Crayons of various kinds, when used to mark cold steel, have properties similar to chalk, somewhat between those of soft and hard varieties, and are used interchangeably with chalk; sometimes in preference to chalk.

For permanent marking on cold steel, paint appears to be the outstanding favorite. However, an appreciable time for drying is required, and its use is most successful for marking pieces which will not have to be moved until the paint has dried. Generally the paint and the marking brushes are of types made especially for steel identification purposes.

Steel surfaces which are warm but not hot are the easiest to mark. Within a limited range of temperature, paint is an excellent medium for permanent marking, since the heat promotes rapid drying. At slightly higher temperatures, however, the painted marks discolor to several shades of brown. At still higher temperatures the paint ignites, portions of the marks may peel or flake off, and what remains is very dark and indistinct.

Special crayons made for marking warm steel are also excellent for this purpose. The end of the crayon melts in contact with the steel surface and produces a mark similar to a painted mark. These crayons have the same kind of temperature limitations as paint. They are more convenient than paint in the sense that one hand is used to mark with a crayon, but two hands are needed to hold a small paint bucket and to paint with a brush.

Hand printing with stamps and stencils — Rubber stamps are intended as conveniences or labor saving devices for applying repetitively marks of the same symbol such as a grade designation, and use a special paint, ink or dye. Metal stencils are also intended as conveniences or labor saving devices for applying repetitively marks which include several characters such as heat numbers or order numbers. They consist of holders in which individual stencil dies may be inserted and fastened, and their use requires a special stencil paint and stencil brushes. Neither stamps nor stencils have found wide acceptance.

In some plants the estimate of the risk incurred is deemed to be excessive if the identification consists only of marks applied to the surface by chalk, paint, or crayon, but it is believed that the risk can be reduced to an acceptable amount by impressing the identification marks into the steel surface. The only economic tools available for this purpose are steel stamping dies. When these are used on cold steel, even of the softest grades, the impressions are shallow and difficult to decipher except on close scrutiny, which makes an unsatisfactory condition for accurate handling at the speed usually used for cold steel. However, sufficiently deep impressions can be made in the surface if the temperature is hot enough; that is above about 1400 F. Such plants adopt a hot stamping practice as a means for insuring permanency of the identification.

In some other plants the identifying requirements are so complex that the risk of permitting the steel to move beyond the hot shear or saw without a physical identification on each piece is deemed to be prohibitive. Hot stamping is the only feasible means for this operating condition.

Hand stamping with steel dies — A simple tool, widely used for this purpose, is a die made in the form of a small sledge hammer and called a stamping hammer. Its use is subject to certain limitations in the size of mark and the depth of impression which can be made. It has one prominent advantage in the flexibility it permits in stamp mark location. It can be used to stamp any of the four surfaces exposed to the stamper: top, near side, or sheared or sawed end front or back, as may be most convenient to subsequent handling.

The person who uses the stamping hammer, often called the "stamper," is not likely always to strike with the face of the die exactly flush with the hot steel surface, and the impression may be in part too shallow or indistinct. The letter or numerals should be large enough that the missing portion of an imperfect impression may be deduced accurately. However, the face of the die cannot be made so large that the average stamper is not strong enough to make a satisfactory impression in the steel. The usual hammer die is of one letter or one numeral, a few are of two characters. Increasing the number of characters beyond one per hammer reduces the size of the individual character impression; it is likely to increase the number of hammers in use, and it increases the chance of error on the part of the stamper in grasping the wrong hammer for the identification of a particular piece. The single die stamping hammer produces an excellent mark for identifying ingot number, cut numbers, tops or discards, ingot sections, and some grade symbols, but is not well suited for stamping heat numbers of from four to seven characters.

However, the heat number is the really important identification. The increased number of characters which designate it have presented a serious problem in hot hand stamping. Because heat numbers normally do not repeat more often than once each year, it is necessary that the stamping die be a composite made up of individual dies of separate characters all retained in one die holder and so retained as to be capable of being replaced readily in accord with the change in heat numbers of the pieces as these numbers normally change in the course of the turn operation.

A hand hammer having a die holder and dies as part of its head is a clumsy tool for striking a swinging blow. Many of the impressions are likely to be of irregular depth and completeness. Some such hammers have been provided with a swivel type socket in the head to assist in striking with the face of the die flush with the steel surface.

In a method designed to avoid such difficulties, the die has been separated from the hammer into two hand tools. One is the die holder attached to a handle by means of which it is placed and held in the desired position on the hot steel surface. The other is an ordinary hammer for striking the die while it is being held. This method is used with some satisfaction for stamping the top surface only.

Some plants find that it is preferable to stamp the identification in the sheared or sawed ends of the hot pieces rather than on the rolled surface. Sheared ends, which constitute the principal tonnage, present an area in two portions: one portion is smooth and slightly sloped due to the action of the shear knife; the other portion is a rough fracture. Many square billets are sheared on the diagonal and the smooth portion is a triangular shaped area making it somewhat difficult for the stamper to place the impressed characters all in the smooth area. Any impressions which happen to be made in the factured area are likely to be illegible. Sawed ends present a relatively smooth flat surface and permit good stamped impressions to be made rather easily.

As already mentioned, the usual hand stamping hammers can be used for end stamping. In addition, where the movement of the hot pieces is lateral on a conveyor or transfer, the location of the pieces permits a more convenient and perhaps a more effective method. The tool is in the form of a short dolly bar with a die holder mounted at one end. The bar is supported near its die end on a slide parallel to and opposite the ends of the moving hot pieces. A hand thrust can provide enough impact for stamping any kind of identification, including heat numbers. The support for the dolly bar permits the stamper to produce more uniformly stamped marks than are made by swinging hand hammers.

Mechanical stamping with steel dies — In normal operations the use of the same symbol is repetitive for heat number and grade during an appreciable period of rolling. The number of characters in the heat number is such that the force which one man can exert to impress them into the surface limits the size of the characters to a smaller dimension than is desirable in the subsequent handling. Sometimes the rate of producing the hot pieces is faster than hand stamping can be performed. Also the expense of hand stamping in some operations is not an inconsiderable sum. These conditions favor the adoption of mechanical means for hot stamping.

An elementary form of mechanical stamper consists of one removable die attached to the face of a rigid bumper so located that the end of the hot piece can strike it or be pressed against it. However, the end of the piece may not always contact the die squarely, and the force of the impact may not be constant. In recognition of these variations the die is usually a single character of large size. Its rather blunt impression is found to be adequate for the identification of steel grade in those operations where the code is in a simple form such as a single capital letter for each grade.

For stamping heat numbers it is necessary to have a greater impact and a more positive control of the positioning of the identification mark. Most of this marking is done with stamping wheels or stamping machines; but one exception is a powered hand tool.

Pneumatic hand stamper — This is in the general form of a pneumatic hammer, adapted to accommodate a die holder and provided with a long handle which also serves as an air pipe to which the compressed air hose is connected. It is best suited to be used in a horizontal position such as stamping the ends of pieces at a time when they are stationary on a cooling bed or transfer, but before they have cooled appreciably. In some plants a support has been provided for this tool in the form of a rail parallel to the ends of the hot pieces. The pneumatic hammer is capable of stamping a large number of pieces in a very short time, but, since its power is limited to what can be developed in a hand tool, the size of the characters in a heat number is rather small. It is used mostly for stamping heat numbers on the ends of small billets. These are produced rapidly and their cross-section is not large enough for a heat number in the larger characters.

Stamping wheel — The stamping wheel is a disc shaped holder of interchangeable dies which are arranged radially to project slightly beyond the periphery of the disc and is rotated on either a spindle or an axle by the friction of the hot piece moving past it, producing one stamped mark with each rotation.

The wheel is mounted in a yoke and the assembly functions as a stamping tool working by steady pressure rather than by impact. In operation the wheel is pressed against the top surface or near side of the moving hot piece just after the first end of the piece has passed the wheel and is held in contact with the steel until the back end is about to pass it. The wheel is then retracted a few inches until the next hot piece arrives. For changing dies the wheel is retracted farther to a position where this work can be done safely and conveniently.

The surface of the piece is never perfectly straight; it does not move in a perfectly straight line past the wheel; and the pieces are not all the same size. Therefore, the pressure which holds the wheel against the surface and which should be constant must be applied in a manner which permits the wheel to change its position while maintaining a constant pressure on the piece. All of the suitable sources of pressure are in use: springs, counterweights, pistons in air, steam, or hydraulic cylinders, and combinations of these sources.

In order to provide the movements which place the stamping wheel in any of its three required positions, the yoke is connected to the sources of pressure by a mechanism which is generally a system of levers and cracks, and, because the stamping pressure is applied ultimately to the table rollers, this mechanism is anchored to some portion of the table or the table foundation.

The location is usually at a point far enough ahead of the shear or saw to allow the back end of the longest hot piece to pass the wheel before the front end is stopped to make the first cut. It can be placed after the shear or saw to stamp individual billets, blooms, or slabs, but the increased number of movements required and the resulting increased number of occurrences of impact produce excessive wear unless the individual pieces are at least some 20 feet long.

The stamping wheel is a successful device in a limited field, especially for stamping heat numbers and grades, or both, on the surface clearly and at a high rate. The characters are not as large as otherwise might be desired, and it cannot stamp ends.

Stamping machines — In contrast to the stamping wheel, the stamping machine is a direct substitution for the stamper wielding a stamping hammer in order to obtain greater impact and more accurate alignment in the stroke, resulting in larger and clearer marks, especially heat numbers, and at the same time retaining the ability to stamp ends.

It consists of a die holder for interchangeable dies, a source of power, and a mechanism to provide three motions. Because the desired action is impact rather than pressure, the source of power is a piston operated by compressed air or steam. The three motions are to strike the piece with the die, to retract the die for the next stroke, and to move the die holder to a location for changing dies. The machine can be so mounted as to stamp in a direct line with the travel of the piston. In this arrangement the machine may be exposed continuously to the heat radiated from the hot steel surface, and unless the mounting includes means for moving the machine during die changing, the act of changing dies may be difficult. Other arrangements include a system of levers and at least one crack to translate the motion of the piston to that of the die. This permits a stationary mounting; only the die and its actuating arm need to be exposed to the heat and then only at the instant of stamping; and the die can be returned to a safe and convenient location for changing.

The fixed mounting of the machine requires that all hot pieces to be stamped stop at the same location and that each piece be stationary during stamping. In most mills the one location which permits this condition without retarding the mill operating rate is the approach table to a single shear or saw where the piece is stationary during the time required to make the cut. In this location the machine can stamp either the top surface or the near side of the original hot rolled section. If, however, end stamping is required, the machine must be located at some point following the cutting operation; for example a section of a roller table from which the pieces are pushed laterally onto a piler or a transfer or a cooling bed, provided that the hot pieces arrive at this section of the table one at a time and are pushed off at the same rate.

In addition to the necessary manual control, the stamping action can be controlled automatically. For example; if placed ahead of the shear, the control for the shear's cutting action can be used to actuate the control on the stamping machine, and the original hot rolled section will be stamped once during each stroke in a location to produce one stamped mark on each resulting piece. This is a desirable feature when a large number of short pieces are to be cut from one ingot.

It will be apparent that this kind of machine is not well suited for use in conjunction with the flying shears and skew tables of continuous billet mills; nor for mills where the normal practice is to cut more than one piece at a time in a single shear or saw; and that for a mill using gang saws or gang shears it would be necessary to provide one machine for each saw or shear. Its practical application is to blooming and slabbing mills and to those mills rolling billets whose practice it is to cut one piece at a time in a single shear or saw.

MARKING PRACTICES

Semi-finished pieces which have not been hot stamped are identified in their first location, while still hot, by various temporary means suitable to the location. If they are to remain undisturbed until cool enough to be marked by paint or crayon, as on a cooling bed or in a pile on the ground, some rather common expedients are pieces of scrap sheet, light gage plate, or other material which will not be destroyed by the heat and in sizes convenient to be handled by one person. The identifying symbols are marked on these with chalk, permitting their re-use, and they are laid on the top surface of the pieces at both boundaries of the group of pieces on the cooling bed, or leaned against the bottom pieces of a pile on the ground. If the hot pieces are loaded directly from the shears or saws into buggies or trucks, similarly marked articles may be laid on top of the load or attached to the buggy or truck, but more often the buggies and trucks have permanent identifying numbers and these numbers in a record serve as the temporary identification of the steel.

Later the pieces on the cooling bed or in the piles are marked with paint or crayon appropriate to the then existing temperature. The pieces on the top layer in each truck or buggy may be marked in the same manner, or all the pieces may be unloaded, piled, and then marked.

The hot stamped identification marks are usually in characters from $\frac{3}{16}$ to $\frac{9}{16}$ in. high. These are quite small for convenient and accurate reading at the rate in which semi-finished steel normally is handled, especially at night under the moving lights and shadows from the overhead traveling cranes. In many plants where hot stamping is employed the pieces are re-marked with paint or crayon in larger and more distinct symbols.

The usual size of painted or crayon symbols is about $1\frac{1}{2}$ in. high with outlines about $\frac{3}{16}$ in. wide, if the area of marked surface is large enough. Symbols of this size are not only clear and distinct when viewed in rolling mill environment, but they are of a size which seems to be the easiest for rapid and careful printing using the marking brushes and crayons now available. Smaller size characters are printed on smaller areas to a limit of about $\frac{3}{4}$ in. high with outlines about $\frac{1}{8}$ in. wide. Sizes smaller than this require skill beyond the talent of the usual marker, require too much time to make without blurring, and are not sufficiently visible. The area to be marked is chosen with such limits in mind.

There is usually one preferred location for the final identifying marks on each piece, the selection of this spot depending on the number of necessary symbols and the steel handling practices. Sometimes it is preferred to exhibit part of the identification, such as the heat number, in one place on the piece and all other identifying marks in another place.

With negligible exceptions, all semi-finished steel is piled at least once in the cold condition and unpiled once, piling in this sense including loading into cars. In the piles all pieces are arranged with their longitudinal axes in an approximately horizontal position. In this arrangement both ends of each piece are exposed, but only one or two sides of the pieces forming the outside of the pile can be seen. Thus, if the identification is placed on either end of the pieces, every identifying mark can be seen in the pile. But, if it is placed on one of the four sides of square pieces, then the chances are only about 3 to 10 that the side carrying the mark will be exposed, provided every piece has been marked before piling, unless extra work has been incurred to turn the pieces during piling; and, if only some have been marked, the chances are even less. If the pieces are

slab shaped and marked on the flat, none will be exposed except the top layer; while if marked on the edge, the chances of exposure are 1 to 2.

Also, a substantial portion of semi-finished steel is subjected to various forms of surface conditioning. The surface removed in this operation may obliterate identifying marks, especially those relatively small marks made by the several hot stamping methods. If in such event the piece is not re-marked at once, there is a strong likelihood that the identity may be in doubt later.

All of these factors favor the sheared or sawed end as the preferred location of the final identification, but the dimensions of the ends place limits on what can be done. It requires a relatively smooth surface, about 3 in. wide by 10 in. long merely to accommodate a 6-digit heat number in full size characters, or 1½ in. by 5 in. for the smallest or half-size characters. Correspondingly larger areas are needed if the identification is to include symbols for grade, size, weight, purpose, or combinations of these identifications.

Large slabs from 4 in. to 10 or more in. in thickness and from about 24 in. to 60 or more in. wide have sheared ends large enough for a heat number plus some or all of the other symbols, and most such slabs do have the complete necessary identification painted on one end. This is also the general practice for large blooms, 8 in. by 10 in. and larger.

Smaller sections have one or more of the identifications, other than the heat number, marked on the top surface or edge close to one end, and the heat number marked on the same end. The limit is reached with pieces 2 in. thick and about 5 in. wide which can accommodate only a heat number in half-size characters.

Sections less than this in thickness or in width usually have the entire identification marked in full size characters on the rolled surface or edge, but close to one end.

In come plants, where it is deemed advantageous to have the identification appear conspicuous, the ends of the pieces are painted black first, and after this has dried, the identifying symbols are painted over the black background in white, ivory, buff, or light yellow. Unless the black paint is of the proper composition and is permitted to dry thoroughly, it may be absorbed later by the paint in the symbols, resulting in symbols which are not as satisfactory as those painted directly on the bare steel. This is a relatively expensive but not uncommon practice.

Where a color code is used to identify the grade of steel, the grade is usually more important to those handling the steel than is any other identification. Almost always the colors are painted on the ends of the pieces to the exclusion of any other painted marks. The other required identifications are painted on the rolled surfaces or edges.

In a discussion of this kind, little can be said concerning the identifying practices in any one plant. Each has its own practices which have been developed to provide correct identification.

DISCUSSION

PRESENTED BY

W. H. BENNETT, Metallurgist, Bethlehem Steel Co., Johnstown, Pa.

C. S. LAMBERT, Superintendent, Youngstown Sheet & Tube Co., Youngstown, Ohio.

LOUIS MOSES, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

W. H. Bennett: I might say for our place, we follow, pretty much, the rules and regulations that Mr. Hill has spoken of here. In addition to that we have numerous discussions on the seriousness of mixed steel. It is one of our problems, and when we have a mix everybody hears about it. Our men go all out to avoid mixes. Mixed steel is serious, for instance, when you discover you have some hard steel mixed in with some soft steel, that will not be all, because somewhere along the line you may have some soft steel in with some other customer's hard steel. I tell our men they can do almost anything to the order except mix the steel. They can roll it oversize, or undersize, can have pitted surface, sheared too long, sheared too short, loaded in the wrong car, loaded too late or too early and the customer will find the error. But if you mix the steel on him he does not know it until he starts to work it, and then it is too late.

All I can do is ask Mr. Hill, and everybody here, to stress the seriousness of mixed steel because there is nothing that will create doubt in the customer's mind quicker or more completely than mixed steel.

Sometimes we cold stamp bars with the heater number or some other symbol, but generally we do not stamp hot bars, or cold bars either.

C. S. Lambert: I am sure many of you are aware of the importance of maintaining the identity of steel in your operations in order to insure proper fulfillment of the customers' order. Today with the ever increasing numbers of special grades of steel, the job of proper identification is even more important than ever before and must be constantly fixed in the minds of your supervisors who are directly responsible. Training in this field is not wasted time. I know many of you have devised systems within your organization to combat this problem. However, in my experience none are foolproof. In my rolling mill experience I have seen billets stamped on the ends, on the side, used heat resisting paints, wires, and many other methods some of which are more sound than others. However, regardless of the system used, it is no better than the effort made by you and your supervisors to be alert to the problem and by adequate training of personnel mixed steel can be avoided.

Louis Moses: Mr. Hill's description of identification marking largely applies to those of my own company. Of probable interest to him and to others would be the manner in which renewal of marking is accomplished when it has become obliterated by weather or more than ordinarily sustained periods of time. At Sparrows Point the upper halves of rusty end surfaces are painted with a mixture made with one gallon of shellac into which is stirred about one and one-half pounds of lamp black. After drying in about ten minutes, this becomes a splendid surface for remarking by paint stick or brush and will remain in good condition for two years.

A MACHINE TO COLD REDUCE 18-IN. TUBING

By GRAHAM B. BROWN
Administrative Assistant
Tube Reducing Corp.
Wallington, N. J.

. . . . this new equipment will cold reduce tubing much larger than previously possible . . . .

▲ DURING World War II the tube reducing process as originally developed by our company was utilized to make a steel core for aircraft propeller blades. Subsequent development of larger propellers, rockets, jet engines and other military items have increased the demands for precision quality large-diameter, light-wall seamless tubing. The Department of Navy, Bureau of Aeronautics, anticipating this need, surveyed the various means of obtaining such large tubing without extensive machining of heavier wall tubing or forgings.

Based upon the World War II experience with smaller tubing, (5-in. and under) they suggested that our company consider the design of a tube reducing machine of sufficient size to produce the largest diameter tube which it was contemplated would be needed in the foreseeable future. After preliminary studies showed large tube reducers to be feasible, a design project was launched.

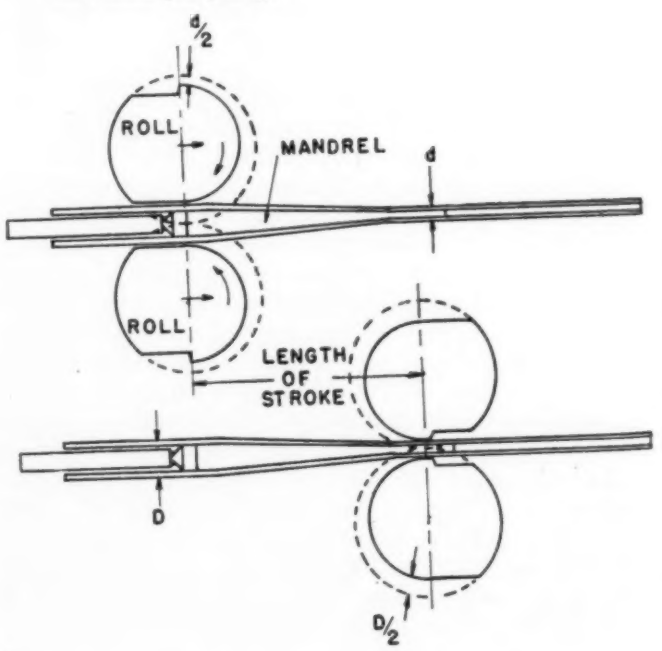
THE TUBE REDUCING PROCESS

For the benefit of those who are not entirely familiar with tube reducing machines, a brief review of the history and the principle will be worth-while. The process was discovered accidentally, when in 1928 an experimental machine for tapering golf-shaft tubing accidentally jammed and produced a straight tube of greatly reduced cross-section area. This accident might have passed unnoticed, except for the fact that a few people with imagination saw it and recognized a revolutionary means of actually cold-rolling a tube. The subsequent development was long and detailed.

The process produces cold-finished tubing but in a fashion entirely different than the usual methods of cold-drawing or swaging. It is a rolling operation which might be broadly described as cold-pilgering. However, unlike the pilger mill, the roll housing, or "saddle" as we call it, is mounted on wheels so that it can move back and forth over a stationary tube during rolling, instead of the tube being moved in and out of the rolls. The rolls are driven in synchronization with the saddle motion through gears engaged in stationary racks causing the rolls to "rock" as the saddle reciprocates. Hence the popular term of "rocked" tubing.

The rolls have a tapered groove around half of their

Figure 1 — The rolls have a tapered groove around one-half their periphery.



periphery as shown in Figure 1. The groove is slightly larger at one end than the ingoing tube to provide clearance and at the other end is the proper size to produce the desired finished tube. The mandrel, against which the wall is rolled, is tapered toward the finishing end of the pass to permit the tube, elongating in the outgoing direction to feed free of the mandrel. The clearance between the die and the mandrel at the finishing end determines the finished wall of the tube. Reduction of the section area and the resultant elongation of the tube is accomplished by intermittent rolling of a larger, heavier tube reducing the outside diameter, the inside diameter, and the wall.

To provide draft, the tube is fed forward a predetermined amount when the rolls are at the starting end of the pass. Then as the rolls move toward the finishing end, the section of the tube at each point is a little too large for the roll groove and the clearance area between the dies and the mandrel. Thus the tube wall is compressed against the mandrel reducing it and the section area at each point. The dies push the extruded metal forward out of the finishing end of the machine. To prevent ovality, the pass being actually elliptic rather than circular, and to prevent the formation of fins in the roll relief, the tube is rotated about 60 degrees after each pass.

CHARACTERISTICS

A cold finished tube produced on a tube reducing machine has properties which make it preferable as material for many products. Some of these characteristics of the process are as follows:

1. Mechanical properties in tubes are obtained beyond that possible by cold drawing. The amount of reduction possible in a single pass is limited only by the strength of the machine and by the ultimate compressive strength of the material. The forces on the material are of compressive nature, being developed by the rolls squeezing the metal against the mandrel. This makes possible very heavy reductions as fractures open up much less readily under severe compressive working than under severe tensile working.

   There are no tensional stresses developed in the tube reducing process as the tube beyond the most forward end of the pass is free and unrestricted. Pulling the tube to develop the compression forces which affect the reduction is not necessary. Single pass reductions in excess of 95 per cent have been taken, resulting in ultimate cold-worked strengths beyond that which can be arrived at on an accumulative basis by successive passes of smaller reductions. Intermediate stress relieving is not necessary or possible when the ultimate reduction is accomplished in one pass.

2. Concentricity of rotary pierced tubes is considerably improved. The eccentricity of reduced tube will be less than 5 per cent when it is made from hot-finished tube within the commercial tolerance of 12½ per cent. This more perfect concentricity often makes possible the use of a tube as rolled, when otherwise machining would be required to attain such close concentricity. In those cases where nearer perfect concentricity is required, the allowance for machining is greatly reduced by use of a rocked tube.

   The outside of a rotary pierced hot-finished tube might be a perfect cylinder, but, unless the tube by chance is perfectly concentric, the inside is a helical spiral, the center of the inside circle, in any cross section, being displaced from the center of the outside circle by the amount of the spiral. Thus a longitudinal section appears as shown in Figure 2a, the wall varying in a wave-like fashion along the length. The mandrel of the tube reducing machine is long enough to bridge the thin portions of the wall. Since the mandrel is solid and rigid, the dies can reduce the heavy wall against the mandrel on one side of the tube while sinking the lighter wall inward to meet the mandrel on the opposite side, as shown on Figure 2b. However, since the mandrel is not absolutely rigid, total elimination of eccentricity is not attained.

3. Close tolerances on diameter and ovality are obtained even in very small wall to diameter ratios. Adjustment of dies can be made to compensate for wear; the tapered mandrel can be adjusted lengthwise to obtain accuracy of the inside diameter or

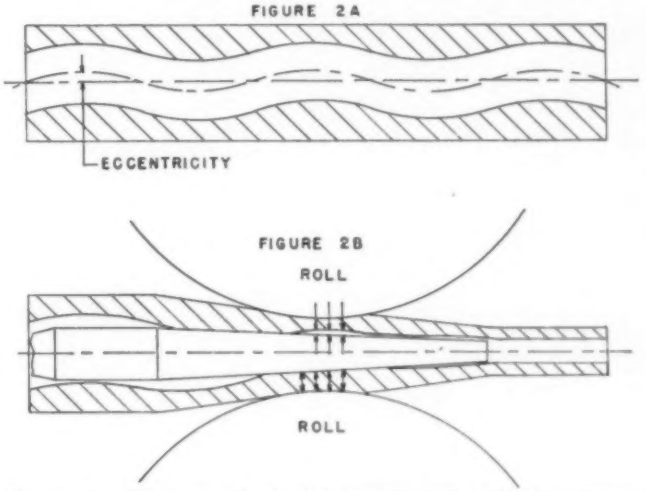


Figure 2 — The mandrel eliminates most of the eccentricity on the inside of the tube.

the wall thickness. These factors are not affected by the wall to diameter ratio. Since there are no tensile stresses, a minimum wall is not required to permit safe pulling. The only limitation on thinness of wall on a controlled tube seems to be inability to keep the tube from pinching in the roll clearance. Tubes have been rocked in production with wall to diameter ratios of less than 1 to 100.

4. Extremely fine surface finishes, inside and outside, without longitudinal scratching or scoring, are standard conditions. There is a slight amount of closely controlled slippage between the die and the tube which burnishes the outside. There is a repeated striking of the inside surface against the highly polished mandrel producing a planishing action. In addition there is the usual effect of decreasing the severity of surface defects through spreading them out as the surface area of the tube increases when it is elongated. The combination

of these produce superior surface which on some types of steel has been found to yield profilometer readings as low as five microinches.

5. Various degrees and combinations of diametric and wall tapers can be obtained. Such is often desired to produce tubes closer dimensionally to the final product to save material and labor in further shaping and machining. The aircraft propeller cores are tubes of this type.
6. Wrought physical properties and close tolerances can be obtained in tubes made of alloys which cannot be rotary pierced with any great degree of success, if at all. A large, heavy-wall blank can be centrifugally cast, hot extruded, pressed of powder, or fusion welded. This blank can be processed to any desired degree in one or more passes on the tube reducer.
7. Metals with very low tensile strengths in relation to compressive strength or those which tend to seize or gall when moved in contact with other metal surfaces can be cold-worked by rocking. The relative motion between the die and the tube is negligible as compared to that on a drawbench. These characteristics plus economic considerations led to the decision to proceed with the development of large tube reducers to produce the products required.

BASIC INVESTIGATIONS

The largest tube reducing machine which has been operated to date is able to use an ingoing tube as large as 6½-in. diameter. To suddenly jump to a diameter about three times as large could not be done directly without an investigation to determine the feasibility and limitations of a large machine. Detailed measurements of separation loads, driving loads, feeding forces, etc., were made on the existing 6½-in. machines. The measurements were evaluated and applied to analytical relationships, derived mathematically, in order to test the validity of the functions and to establish key empirical constants. These functions and constants were then used to investigate the characteristics possible in a larger tube reducer. The results indicated that two machines would be necessary to cover the range of sizes from the largest now produced to the largest required:

1. A 10-in. machine, using raw material ranging from 6 to 10 in. outside diameter to produce tubing 5 to 9 in. outside diameter.
2. An 18-in. machine, using raw material from 10 to 18 in. outside diameter to produce tubing 9 to 16 in. outside diameter.

Preliminary design investigation was limited to the 18-in. machine, recognizing the fact that the 10-in. machine would be somewhat a scale model. Assuming that operating limitations on reduction and pass design would be controlled by the same factors in the large machine as in the existing smaller machines, the roll diameter was established to be in the range from 45 to 50 in. The maximum rolling load was calculated by the usual method of determining the contact area on the roll and the roll pressure, a factor measured on the existing machines. The resultant separating force was found to be about 3,500,000 pounds.

With the preliminary determination of roll size and load accomplished, the detail design of the machine was arranged for as a joint project by two companies. The design progressed through successive stages:

1. Design of the roll housing to hold the large rolls and to resist the separating forces.
2. Analysis of the forces required to drive the roll housing and computation of the power requirement.
3. Design of the hydraulic drive.
4. Design of the general base and framework.
5. Design of the auxiliary equipment to handle the tube, turn and feed the tube, handle the mandrel, guide the tube, etc.

GENERAL LAYOUT

The machine is 100 ft long, being made up of a series of sections, each more or less independent of the other, but each performing an essential function in the operation. The four principal parts are the roll housing section at one end, the drive end, the tube feeding equipment in the center, and the mandrel handling equipment at the other end. The roll housing end is shown in Figure 3. It consists primarily of the "saddle" and the side frames to support the rails on which the saddle travels.

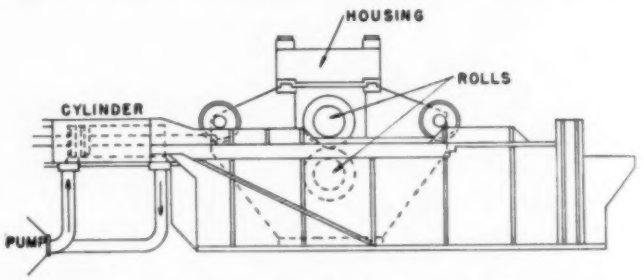


Figure 3 — The machine consists of four principal parts. Illustration shows roll housing end.

SADDLE

The saddle, Figure 4, resembles a 50-in. mill roll housing equipped with four 36-in wheels which suspend it from rails 7 in. above the pass line. Completely assembled with rolls, roll neck bearings, etc., the saddle has a gross weight of 150 tons. The maximum travel of the saddle is about seventy-three inches, the length being that required to rotate the rolls slightly less than 180 degrees.

The large separating forces between the rolls would normally cause a considerable extension of the saddle, making close diametrical tolerance control of the tubing difficult. To offset these strains, four full-length 10-in. diameter corner posts are used through the housing. These corner posts contain heating element units in the center at the top end so that they can be expanded lengthwise by heating. Upon assembly, the nuts on top are drawn down snug on the expanded posts and the posts cooled. The consequent shrinking creates a large compression preload on the saddle frame. This preload must be exceeded during rolling for a separating strain to exist in the saddle.

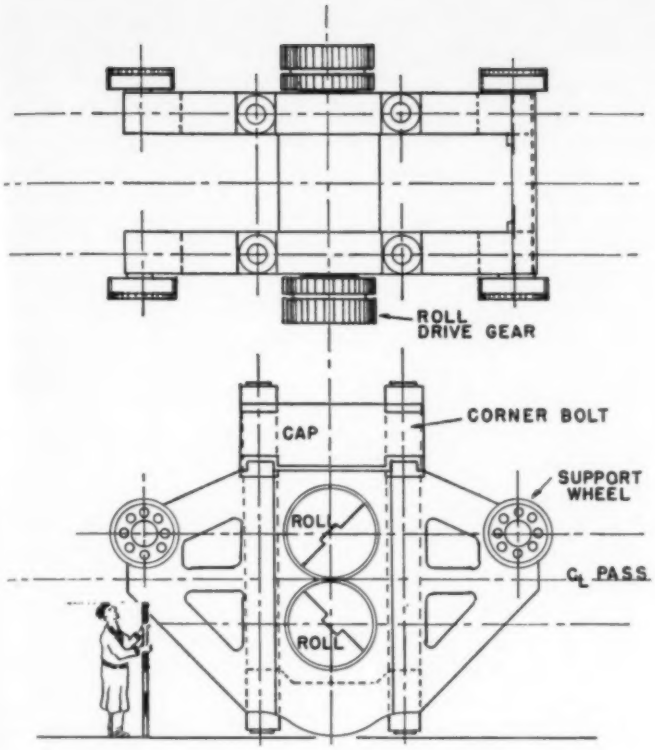


Figure 4 — Saddle section of tube reducing equipment.

The top roll position is fixed securely with respect to the pass line. The bottom roll is adjustable vertically toward the pass line by hydraulic cylinders acting somewhat like jacks under the roll bearing chucks. As the dies in the rolls run face on face, it is possible to preload the hydraulic cylinders to maintain a preset position of the roll up to a specific maximum separating load. The pump and accumulator to load these cylinders is mounted on the saddle and travels with it.

Accidental overfeeding with the consequent jamming of the tapered tube in the dies could result in a high impact load which could damage the bearings, the roll housing, or the drive. The hydraulic cylinders supporting the bottom roll are equipped with safety valves such that in the event that the safe load is exceeded, the oil in the cylinders will be dumped very quickly, removing the support of the bottom roll, allowing it to drop away, immediately opening up the pass and relieving the load.

ROLLS AND DIES

The rolls for the 18-in. machine were established at 50-in diameter, and in the 10-in. machine at 35 in. This final size was determined by the center distance required to permit the use of roll neck bearings of the size necessary to support the rolling loads. In order to keep the reciprocating mass of the machine to a minimum, the rolls have not been designed sufficiently rigid to prevent flexing, since such can be compensated for in the pass design. Double roller spherical bearings are used to permit flexing.

The bearings selected are 48.0315-in. outside diameter, 17.244 in. wide, and have a load rating of 3,200,000 lb per bearing—the heaviest capacity made in this type. They weigh 5150 lb each, the individual rollers weighing 39½ lb. The tapered bore of the bearings matches a taper on the roll neck so that the bearings can be placed by expanding with hydraulic pressure, drawing into proper position on the roll necks, relieving the pressure to properly preload radially, obtaining a "shrink" fit without benefit of heat or presses. The reverse process permits removal without scoring the roll necks.

The top roll, Figure 5, is driven by gears on each end which engage the stationary racks. Toward the center from these gears are the synchronizing gears, which engage in similar gears on the bottom roll to drive it and to assure perfect motion of it with respect to the other roll. The gears have tapered bores and are assembled on the roll necks in the same fashion as the bearings.

The rolls in the 18-in. machine have been designed along the lines conventional in tube reducing machines, with an insertable die in the form of a semi-cylinder. The use of an insertable die greatly reduces the cost of tooling for each size and makes possible the changing of passes on the machine without completely changing rolls. Each die will be approximately 7500 lb of fine grade through-hardening alloy steel, heat treated to provide a surface hardness of Rockwell C-60 to a case depth of about ¾ in. The die is held in the roll by four 3-in. corner bolts. The forces tending to push the die out of the roll are counteracted by a large rectangular key in the center of the roll and by ring segments arranged around the periphery wedged between the die and roll so as to resist the splitting forces on the groove.

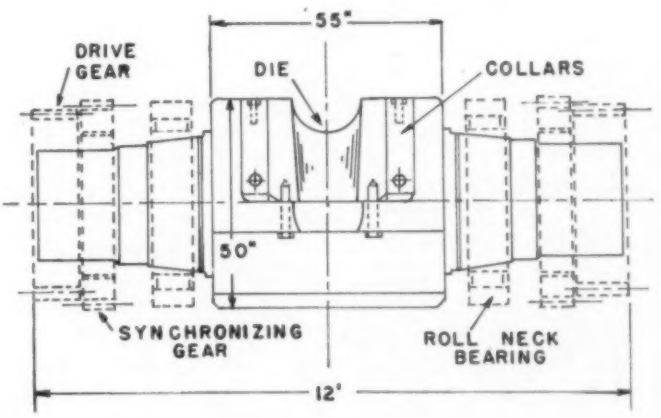
DRIVE

One of the basic specifications for the machine is that it should be made as flexible as possible in order that it will be usable without modification for the greatest range of applications. It is visualized that there will be times when a relatively small reduction would be required, making necessary the use of only a limited area of the die. Conceivably two or more such passes can be put on one such die.

It might be desirable to make a long tapered tube by changing the length of the stroke at a controlled rate as the tube is fed into the machine. Thus, it is necessary that the drive have the following characteristics:

1. The stroke should be variable in length.

Figure 5 — Top roll is driven by gears on each end.



2. The position of a shortened stroke in respect to its location on the full stroke should be alterable.
3. A means of progressively shortening the stroke at a controlled rate should be possible.
4. The speed should be variable as a function of stroke length to provide the maximum productivity.

The load on the drive mechanism is made up of three components:

1. That required to accelerate the mass of the saddle and the rolls.
2. That required to deform the tube.
3. That required to overcome the friction between the tube and the die and between the tube and the mandrel, as well as the friction losses in the roll neck bearings and the drive gears.

The latter two are, generally speaking, independent of the length of the stroke and the speed of the saddle. The first, however, is proportional to the product of the stroke length and the speed squared. Hence, as the stroke is shortened, greater speed should be possible without increasing the load on the drive. Figure 6 shows the speed variation as a function of stroke and also shows the limits of the stroke and the speed.

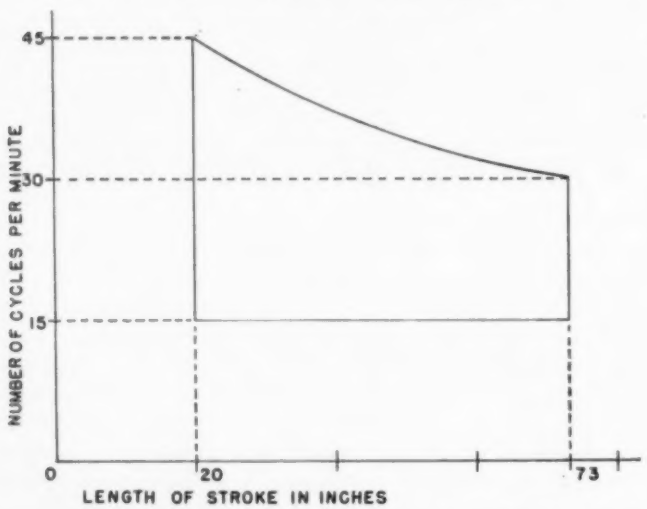


Figure 6 — Chart shows how speed varies with length of stroke.

To really visualize the drive required, imagine three freight cars loaded so that the gross weight is 150 tons. A car puller is attached which will bring those cars from a stop to 600 fpm by the time they have moved 3 feet and then bring them to a dead stop in 3 more feet. Immediately, without loss of time, the motion is repeated in the other direction, and so on, the cars changing direction once every second. The car puller is actually a pair of 13-in. hydraulic cylinders operating under a working pressure of 2200 psi. The oil required is 5400 gallons, 100 drums, every minute.

Each cylinder is driven by its own pump, equalizing lines maintaining coordinated movement. The significant development in the drive is the fact that the reversal of flow and the variation of pressure in the cylinders is accomplished without valves or accumulators by controlling the flow from the pump. The inlet side of each pump is connected to one side of each cylinder, the outlet side of the pumps to the other side of the cylinders. The pumps are of the wobble plate type, rate and direction of oil flow depending on the angle of the wobble plate. The wobble plates cross center just before the saddle reaches one end of the stroke, starting flow of oil into the short end of the cylinders driving the saddle back toward center. When the saddle comes to the middle of the stroke, the wobble plate is at the extreme angle giving maximum flow. However, the inertia of the 150-ton saddle in motion pushes oil out of the decreasing end of the cylinder against the pump. The wobble plate moving toward the center position causes the pump to develop a back pressure which slows the saddle to a stop at the end of the stroke, the pump acting as the brake. The wobble plate crossing center causes the process to repeat in the opposite direction, driving the saddle back again. The pumps, the largest of this type ever produced, have been especially designed for the project.

An ingenious servo-mechanism has been designed to control the wobble plates, using the phase shift between the saddle and the pumps to provide the controlling force. The length and frequency of the stroke is controlled by the same mechanism through the speed and angle at which the wobble plates are moved relative to the saddle motion. In order to overcome the natural tendency of a hydraulic cylinder to drift, when operating at less than maximum stroke, a means is provided to keep the stroke of the cylinder centered about the chosen centerline by removing oil from one side of the piston and putting it in the other side when and if required.

The velocity of the oil in the system has been kept sufficiently low that there will be no heat generated by turbulence. However, the transmission of energy from the pump to the saddle and then from the saddle back to the pump through the column of compressible oil results in a small loss of energy which appears as heat in the oil. To dissipate this heat, a small quantity of oil is continually drawn out of the system on the low pressure side of the stroke through a series of check valves, and is continually replaced at the opposite end of the stroke on the low pressure side of the piston. This oil is circulated through coolers which will require about 10,000 gallons of water per hour.

The pumps are driven through a five-to-one speed reducer with a flywheel on the high speed shaft. This flywheel works in conjunction with the saddle, which in itself is a sort of a flywheel in the sense that it is constantly storing and dissipating energy. The stored energy of the system passes alternately from the flywheel into the saddle and from the saddle into the flywheel. This arrangement makes it possible to use individual 700 hp synchronous motors to drive the pumps. Without the use of the flywheel to conserve the energy returned to the system by saddle, a motor as large as 7500 hp would be required, with most of the difference in energy being lost in heating the oil, thereby greatly increasing the requirement for cooling water. This economy in driving equipment is only possible because the hydraulic system permits cutting the saddle loose, through overload safety valves, from the stored energy of the drive system if a jamming between the tube and the dies occurs.

The pumps and their drive will be located in a pit directly under the drive cylinders in order that the length of piping in the hydraulic system will be the shortest possible. This same pit will contain the

auxiliary equipment, the principal part of which is the hydraulic drive for feeding the tube into the machine and for turning it between strokes.

FEEDING

The tube being rolled cannot be free to be moved through the pass by the action of the rolls, and must be controlled to prevent forward motion as such would cause the tube to jam into the dies. As a pass is designed for a particular work load and this work load is a function of the draft, the draft must be accurately controlled to prevent overloading. The draft being a direct function of the feed, the feed must be controlled correspondingly.

To obtain such conditions, the tube is secured, on the end away from the rolls, in a vise on a crosshead. The crosshead is a large carriage arranged to move on ways approaching the rolls. It contains a hollow spindle supported in roller bearings through which the mandrel rod passes, and on the end of which is mounted the vise.

The crosshead can be run toward or away from the rolls at a speed of 70 fpm in order to push the tube into the machine or to withdraw the crosshead to get it out of the way to load another tube. However the principal function of the crosshead is to feed a tube into the rolls in increments preset in a range from 0.1 to 0.5 in. This feeding is timed by cams such that it takes place immediately prior to each forward work stroke of the rolls, at the moment when the saddle comes to a stop to reverse direction.

The travel of the crosshead is accomplished through a pair of non-rotating feed screws driven by fixed rotating nuts at the rear of the crosshead ways. The mounting is such that if an unequal load develops on the feed screws, the position of the feed nuts will be automatically adjusted to equalize the loads. This arrangement eliminates the possibility of uneven movement of the crosshead on its ways. The feed nuts are driven by a single 200-hp hydraulic motor of the piston displacement type which operates under a pressure of 2000 psi. The intermittent motion of feeding is accomplished by means of metering the oil from the motor through a metering cylinder, the stroke of which is adjustable to permit variation of the amount of feed. Due to the great amount of mechanical inertia, the hydraulic system is, of necessity, equipped with a decelerating feature. To provide uniform pressure, at the time required, the system incorporates a large accumulator, the gas pressure for which is furnished by a self-contained 2000 to 3000 psi nitrogen compressor; nitrogen being obtained from commercial bottles.

TURNING

The tube is turned at three points, by the crosshead vise, by a vise at the outler end of the machine, and by the rotating mandrel. The two vises and the mandrel must be turned in unison as relative motion would tend to apply torsion stresses to both the tube and the mandrel bar. The uniform turning is accomplished through two separate hydraulic motors, in series, one on the front vise and one at the rear of the machine arranged so as to turn both the mandrel bar and a hexagon shaft running the length of the crosshead ways, the latter in turn rotating the crosshead vise. As the rotation is to be intermittent, oil is metered through its circuit in a similar fashion to the feed device.

The peak torque imposed by the mass being turned is such that a 325-hp motor is required. This circuit is also provided with a decelerating feature since the turning must be accomplished in less than 0.1 second.

MANDREL

In order to load a new tube into the machine it is necessary that the mandrel bar be withdrawn and re-inserted through the tube. Such is accomplished by having the rear end of the mandrel bar on a slide in a fashion similar to that used on a piercing mill. The slide is pulled back by a heavy chain hydraulically driven at the rate of 75 fpm. As the positioning of the mandrel bar is quite critical in determining precisely the inside diameter and the wall thickness of the tube, it is locked in place with a pair of hydraulically operated slides which push it forward against a stop, adjustable to very close limits.

RELATED EQUIPMENT

A plant which will use this machine will have to be equipped to manufacture the dies and mandrels required. Ordinary methods of machining will not produce the tapered groove in the large dies. In order to accomplish this, a die machine is being designed using a large vertical boring mill as the base.

There are many problems still to be resolved in the manufacture of these dies, particularly in the heat treating. Experimental projects are underway currently to develop the practices and the equipment.

Other auxiliary equipment is primarily that required to furnish power, cooling water, and lubricating coolant for the rolling operation. A central pressure lubricating system will also be used.

SUMMARY

One each of these large machines are currently under construction. Everyone who has participated in the project is looking forward to that day when these seemingly fantastic machines operate, opening new vistas for design engineers through the use of large diameter precision cold-finished tubing.

DISCUSSION

PRESENTED BY

LOUIS DE VAU, Chief Mechanical Engineer, Steel & Tube Division, Republic Steel Corp., Cleveland, Ohio

GRAHAM B. BROWN, Administrative Assistant, Tube Reducing Corp., Wallington, N. J.

A. B. CAPRON, Chief Engineer, The Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa.

Louis DeVau: I should like to ask Mr. Brown to elaborate a little on how they propose making the rolls. It has been brought out before that these rolls are to be

heat-treated to a case depth of ¾ in. Does this depth indicate the portion of hardened steel as well as the usable portion of the rolls?

What kind of steel is used in the making of these rolls?

Graham B. Brown: We plan to use SAE-52100 steel, which is relatively high carbon steel, and we expect to quench harden. The ¾ in. referred to is the depth to which we would like to obtain full hardness.

On the large machine the steel we are going to use and the amount of hardening we will be able to get is still of an exploratory nature. Without the machine, it is difficult to tell whether a particular die, as we might make it at the present time, would be satisfactory. We actually have to try it out.

Louis DeVau: Evidently, a considerable amount of thought has been given to the safe operation of this machine; one in particular is the installation of a hydraulic system to quickly release the roll pressure in event of over-load. Does the hydraulic system control the full load of 3,500,000 pounds which has been calculated as the maximum separation pressure at the rolls?

Graham B. Brown: The over-load release is actually set to relieve at about 3,250,000 pounds allowing a margin for safety.

A. B. Capron: The tubular products division of The Babcock & Wilcox Co. has been using tube reducing machines for many years in the production of high and low alloy steel tubing for many uses and the production has been as Mr. Brown describes. We found them to be a very helpful addition to our equipment for producing cold finished tubing to close tolerances and with a high grade finish. The 2½ and 3½-in. machines are standard units in many tube mills and are well known throughout the industry.

The new machine which Mr. Brown has described in his paper is such a tremendous step ahead of any tube reducers built to date that the most fitting comment to this paper can be stated in one word, "Whew!" Its size and capacity is so much larger than any other machine now in use on tubing that it staggers the imagination. The problems encountered in the design of such a machine had to be attacked in ways other than those used on the smaller, purely mechanical machines and we were all very much interested in the new design features of this Goliath.

One departure from standard design was noticed in the relationship of the dies which apparently are to operate in contact instead of being operated by an ⅛ in. or so away as on the smaller tube reducers. I wonder how it will be possible to make any allowance for die wear which is done by shimming on the smaller machines.

The development of a machine of this size from a basic idea which works on a much smaller scale is typically American and very interesting to everyone in the tube game. We all look forward to seeing it in operation and wish the best of luck and a minimum of headaches to its developers.

Graham B. Brown: We operate our smaller machines with the dies in contact, the same as we do in the large machines, although I know that some of the users of our machines do run them separately. The question of die wear, of course, is one that is not determinable until we have built the machine.

INSPECTION TRIP TO BETHLEHEM STEEL COMPANY

JOHNSTOWN, PENNA. PLANT

MONDAY, MAY 4, 1953 — 1:00 p.m.

The Bethlehem Steel Company will be the host for an Inspection Trip through the Johnstown plant. This trip will be limited to citizens of the United States and Canada. Men making the trip will meet at 1:00 p.m. at the Iron St. entrance of the Johnstown plant, which is about one-half block from the Pennsylvania Railroad Station. Parking facilities will be available for those who come by automobile. It is suggested that those who drive should double up as far as possible to make best use of the available parking facilities.

Buses will be used on trip through plant, starting and returning to the Iron St. entrance. No private cars will be allowed in plant. Reservations must be sent prior to May 1, 1953 to:

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 Empire Building
Pittsburgh 22, Penna.

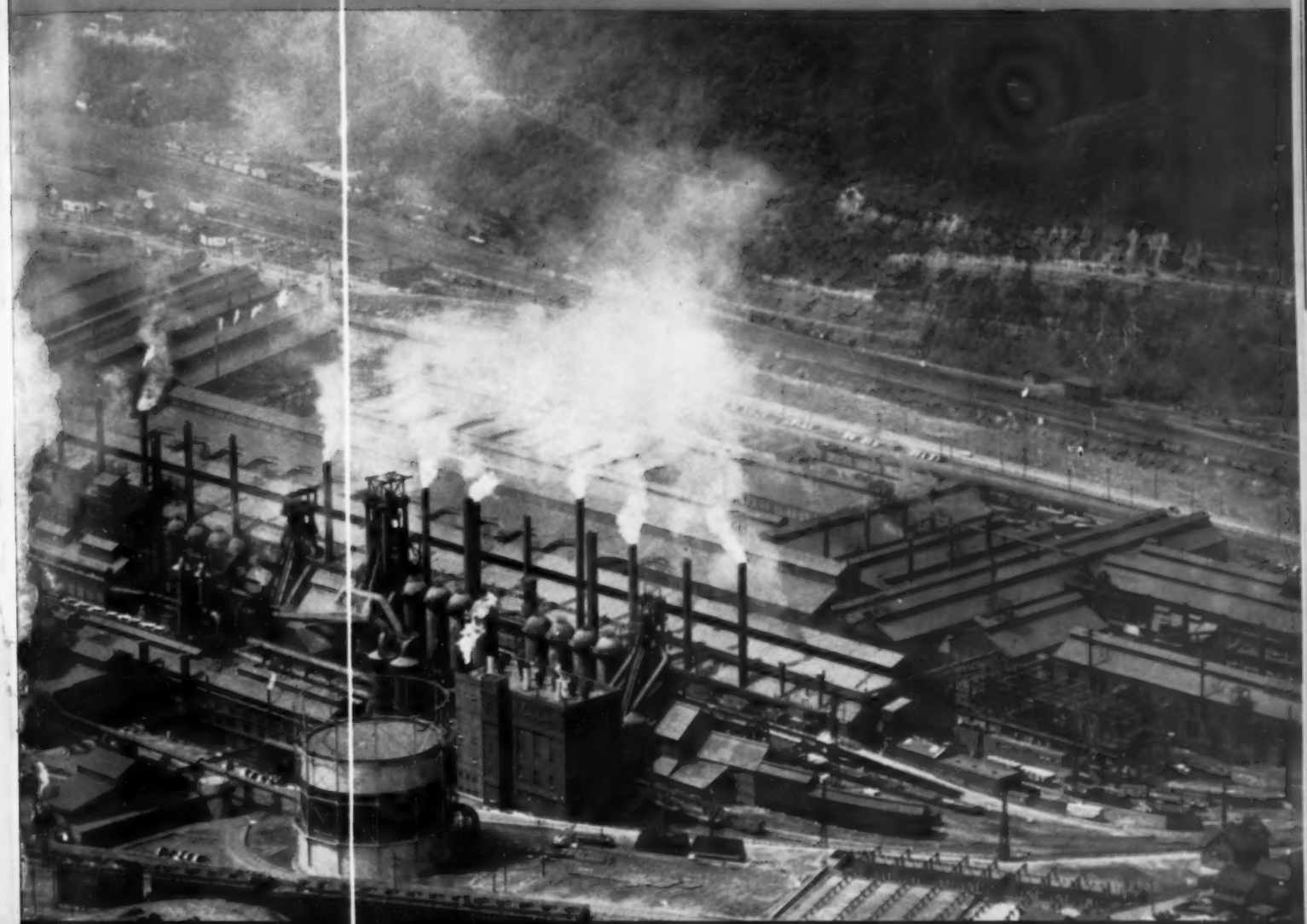
Reservation cards will be sent to all AISE members.

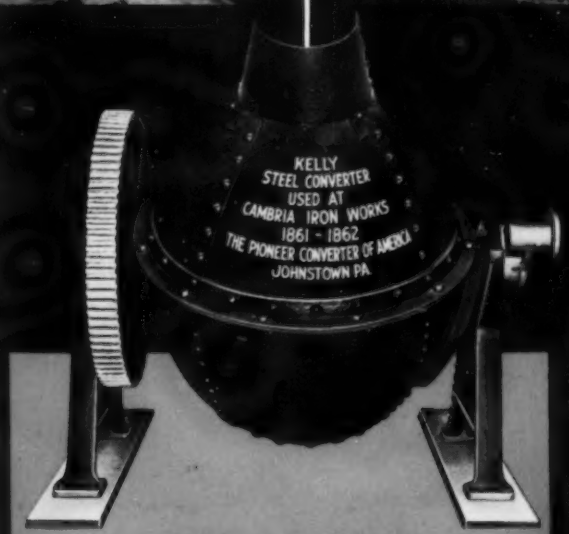
Dinner: Sunnehanna Country Club — 6:30 p.m.

Dinner Price $3.00 — Bus Fare $1.00

Following the dinner, A. J. Fisher, General Manager of the Johnstown plant of the Bethlehem Steel Co., will make a few remarks on the Johnstown plant operations.

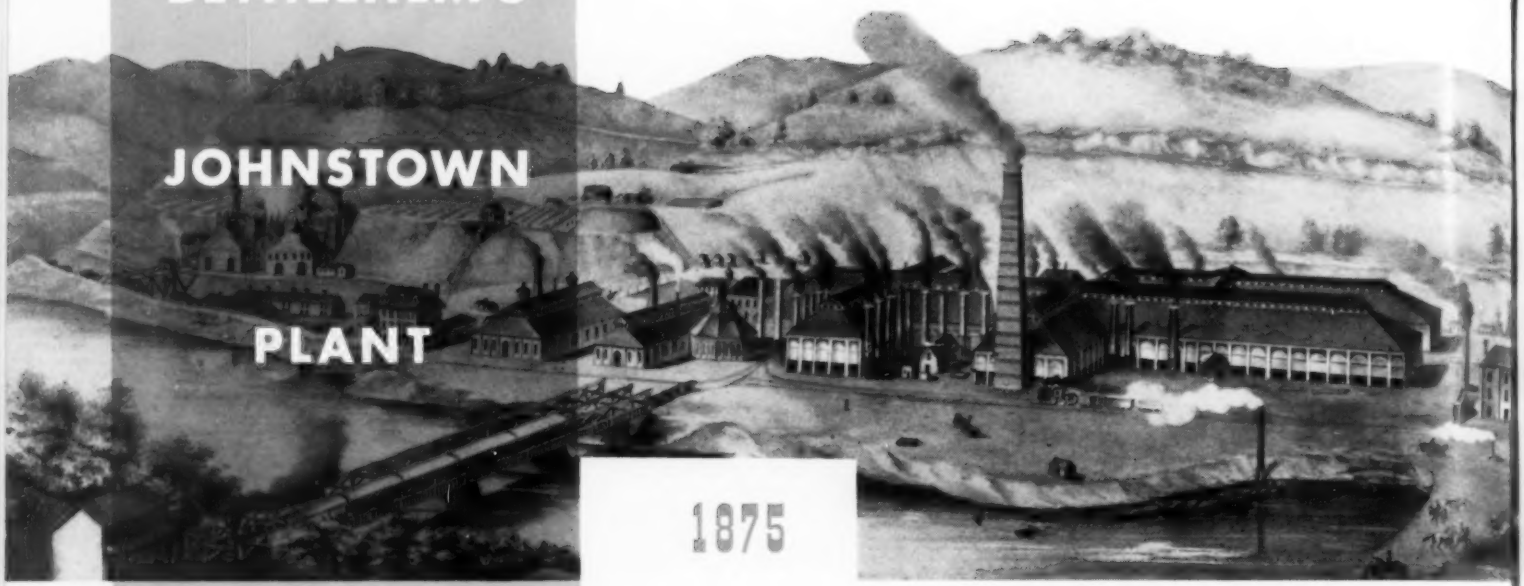
Bethlehem's
JOHNSTOWN PLANT





a century of pioneering

BETHLEHEM'S JOHNSTOWN PLANT



. . . a century of pioneering

By T. J. Ess

▲ BECAUSE the Conemaugh valley provided sources of iron ore, fire clay and wood for charcoal, it became an iron producing area almost 150 years ago, when one of the first charcoal furnaces west of the Allegheny Mountains was built near the village of Johnstown. In 1852 a charter was issued for the formation of the Cambria Iron Co., the nucleus of which consisted of three charcoal iron furnaces.

One hundred years ago, these furnaces were each turning out about 30 tons of iron per week, and four new furnaces with 15-ft hearths, to be fired with coke, were being built. Sixty puddling furnaces were installed to feed two rotary squeezers and two alligator squeezers.

Financial difficulties plagued the company during the early years of its existence, and were only solved when the successful production of a big order of rails encouraged investors to buy stock in the company. In 1857, John Fritz completed the construction of a three-high rolling mill, which increased production materially and gave Cambria a leading position in the rail market.

Between 1857 and 1862, William Kelly carried on much of his experimental work on the pneumatic converter at Cambria, and his small unit is now displayed in the plant office. Cambria quickly adopted the new steel-making process, and in 1867 it rolled what was said to be the nation's first commercial order of steel rails. Converters were used in the plant until 1952, when the last two were removed. John Fritz was succeeded in 1860 by his brother George, who developed and patented the blooming mill with roller tables and hydraulic manipulators.

Cambria continued to thrive and expand until, in 1873, it was rated as the nation's largest iron and steel plant. It then contained nine coke-burning blast furnaces, two converters, a blooming mill, a rail mill, and several bar mills.

In 1878, two 10-ton open hearth furnaces were built, and in the same year the Gautier Mills of Jersey City, N. J., were acquired and moved to the Cambria plant. These mills produced plow steel, merchant bars, wire products, wagon tires, carriage springs and miscellaneous products, and formed the basis for the extensive merchant mill operations of the present Johnstown plant.

Rebuilt after the disastrous Johnstown flood of 1889, the plant continued to grow, and in 1898 was incorporated as the Cambria Steel Co. The Midvale Steel and Ordnance Co. acquired the plant in 1916, and in 1923 it became part of the Bethlehem Steel Co.

The history of the Johnstown plant is truly a century of pioneering in the production of iron and steel. In addition to the innovations previously mentioned, the plant witnessed the development of the hot metal mixer and the bottom pouring of ingots, the application of heat treatment to car axles, the establishment of the first steel plant metallurgical department, and the production of the first soft center plow steel.

Three years ago an expansion program was started

which has thus far included new coke ovens, blooming mill, soaking pits, billet mill, complete rebuilding of open hearth furnaces, and rearrangement and modernization of various other facilities. Other projects are now under way and many more are under consideration. These activities emphasize the importance of the Johnstown plant in the overall set-up of Bethlehem Steel Co., and point to continuance of major operations there in spite of some obvious economic disadvantages of its geographical location.

Today the Johnstown plant includes six principal divisions stretching for some 12 miles along the valley of the Conemaugh and Little Conemaugh Rivers. Starting at the up-river end, there is the wheel mill, followed a mile below by Franklin division, where steel producing, primary rolling, major coke and iron producing facilities, and a car shop are located. Next is Gautier division, composed of ten rolling mills and a number of manufacturing shops, and then the Lower works, which is the site of the original Cambria plant, and now includes blast furnaces, major maintenance shops, an axle shop and a truck assembly shop. At nearby Rosedale is a coke plant.

About two miles below the Lower division is the rod and wire division, containing a rod mill and extensive wire drawing and finishing facilities, and finally, about a mile farther on, the fabricating shop, where long span joists are fabricated.

RAW MATERIALS

Iron ore comes to Johnstown from the Mesabi and Old Range fields via lake ore carriers to the lower lake ports of Erie, Cleveland, Ashtabula and Lorain, and thence by rail to the plant. Here the ore is dumped by car dumpers and distributed in the storage yards by bridges and transfer cars.

There are two ore storage yards, one at Franklin division and one at the Lower works. The Franklin field, 254 ft wide × 1511 ft long, lies adjacent to the blast furnace stock bins and has a capacity of 1,200,000 tons of ore. It is served by a movable car dumper and two 11-ton ore bridges of 304 ft span. Ore cars are dumped directly into the yard, and the ore is piled by the bridges. The bridges also reclaim the ore, putting it into 60-ton electrically operated transfer cars. Four of these cars (three with 60-ton trailers) keep the bins of the Franklin furnaces stocked with ore and coke. The field at the Lower works is 297 ft wide × 1100 ft long and will hold 800,000 tons of ore. It is provided with a stationary car dumper which dumps into a 150-ton electrically operated transfer car, which in turn dumps into the field. Two 11-ton ore bridges, of 297 ft 6 in. span, distribute the ore over the field and also reclaim ore from storage, loading it into hopper cars which are then shifted to the furnace stock bins and dumped.

To improve the blast furnace charge, about 100,000 tons of ore per month is screened at the sintering plant at Franklin, yielding some 60,000 tons of fine ore and 40,000 tons of charging sizes. The fine ore is blended with flue dust and culm coal and processed to produce approximately 90,000 tons of sinter per month.

The sintering plant contains two traveling grate machines, 72 in. wide × 95 ft long. Each unit contains 13 windboxes and is equipped with a suction fan rated at 115,000 cfm at 27 in. water column suction and 250 F. Approximately 7500 tons of iron ore and sinter are used per day. The ore varies in analysis and is mixed in the blast furnace charge to meet operating requirements. Analyses range as follows:

	Per cent
Fe	48-56
P	0.04- 0.10
S	0.01- 0.30
SiO	3.0 -10.0
Al_2O_3	1.0 - 3.0

One of the economic advantages of the Johnstown plant is its proximity to coal supplies. On the immediate premises are mines that produce low volatile coal, which is received at the plant in the mine cars and distributed by conveyers. High volatile coal comes from the Pittsburgh district by rail. The low volatile coal is washed at the coke plants, while the high volatile is received already washed. Daily use is approximately 2700 tons of low volatile and 4950 tons of high volatile coal.

E. G. GRACE

A. B. HOMER

S. J. CORT

A. J. FISHER

Franklin ore yard, served by a movable car dumper and two bridges, has a capacity of 1,200,000 tons of iron ore.

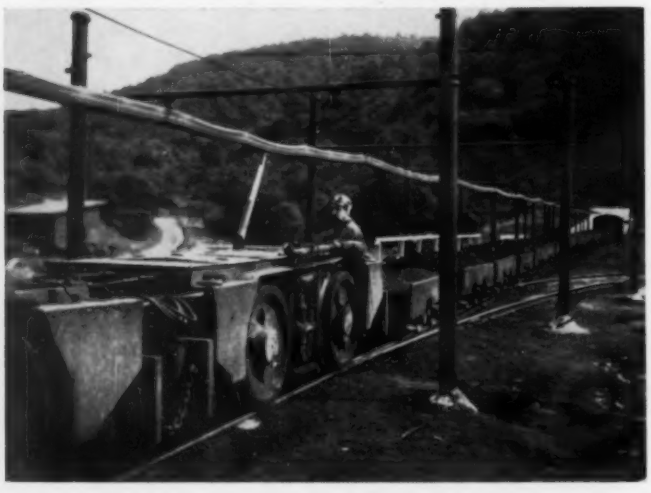
Analyses average as follows:

	Low volatile coal		High volatile coal
	Raw	Washed	
Volatile matter	16 -18	17 -18	34 -35
Fixed carbon	68 -70	74 -75	57 -58
Ash	12 -15	6.9- 8.0	7.5- 8.5
Sulphur	2.2- 3.0	1.1- 1.3	1.2- 1.3
Mn	....	....	....

At the plant, storage is provided for about 500,000 tons of coal. Stocked coal is reclaimed from storage by cranes, bulldozers and trucks or railroad cars.

Limestone and dolomite come by rail from company owned quarries in Pennsylvania. At the plant the material is handled by the car dumpers and bridges serving each storage yard. A portion of each yard is set aside to store about one month's supply of these fluxes. Daily requirements run about 1200 tons of limestone and 800 tons of dolomite. Analyses average as follows:

Low volatile coal comes to the Johnstown plant directly from mines on the plant property.



	Per cent	
	Limestone	Dolomite
CaO	52	31
MgO	1.8	20
SiO_2	2.0	1.0

COKE PLANTS

Coke is produced in two separate by-product coke plants, one at the Franklin division and one at Rosedale, about four miles away. At Franklin, there are 228 ovens arranged in three batteries. One battery of 77 ovens, each 40 ft 7⅝ in. long × 12 ft 5¼ in. high, is heated by mixed coke gas and blast furnace gas in vertical flues in a two-divided arrangement. Another battery of 77 ovens, heated in the same manner, has ovens 40 ft 1⅜ in. long × 12 ft 3 in. high. The third battery, containing 74 ovens 40 ft 7⅝ in. long × 12 ft 5¼ in. high, is heated by straight blast furnace gas, straight coke gas, or a mixture of the two, in vertical flues in a four-divided arrangement. All of these ovens are 16 in. wide on the pusher side and 20 in. wide on the coke side, and hold 17 net tons of coal.

Seven batteries of by-product coke ovens in the Johnstown plant provide an annual capacity of 2,268,000 net tons of coke.

At the Franklin plant, the low volatile coal, direct from the mines, is passed through breakers rated at 340 tons per hr, then through the washer and into drying pits. From these pits, the coal is taken to the mixing station. High volatile coal is put through a crusher rated at 300 tons per hr and then conveyed to the mixing station. The mixed coal then passes through 300-ton per hr crushers, where it is reduced so that at least 80 per cent passes through a ⅛-in. screen. The crushed coal is then conveyed to two oven storage bins located over the three batteries, from which mechanical charging larry cars take it to the ovens.

When coking is completed (approximately 18 hr per oven), the coke is pushed, quenched, screened, and conveyed to the blast furnace stock bins in transfer cars. The coke breeze goes to a boiler house.

At Rosedale there are 208 ovens arranged in four batteries. Two batteries contain 60 ovens each, with ovens 38 ft 0⅝ in. long × 9 ft 11¼ in. high, and 15–19 in. wide. Each oven will take a charge of 11.6 net tons of coal, and is heated by coke gas burned in vertical flues. The other two batteries, of 44 ovens each, have ovens 35 ft 0¾ in. long × 12 ft high and 17½ to 19½ in. wide. Each of these ovens will hold 14.4 net tons of coal and is heated by coke gas in horizontal flues.

Coal and coke handling at Rosedale are, in general, similar to the Franklin practice. Normal coal charges consist of 35 per cent low volatile coal and 65 per cent high volatile coal. Coke yield averages about 73 per cent of furnace coke and 3–3.5 per cent of breeze. Analyses of the coal charged and the coke produced average about as follows:

	Coal charged	Coke
Volatile matter	27 -28	1.4 - 1.5
Fixed carbon	64 -65	88 -89
Ash	7.8 - 8.2	10.2 -10.8
Sulphur	1.27- 1.28	1.05

At both coke plants there is a by-product plant consisting of primary coolers, exhausters, saturators and dryers, ammonia still, pyridine still, final coolers, light oil absorbers, boosters, light oil stills and tar decanters. The Franklin plant also includes a tar plant and a light oil fractionation plant.

By-product yields range as follows:

	Per ton of coal	
	Franklin	Rosedale
Gas, cu ft	10,000	10,000
Tar, gal	7.5	7.5
Light oil, gal	3.0	2.75
Ammonium sulphate, lb	20.0	20.0

Normal production schedules show 303 ovens pushed per day at Franklin, with a coal consumption of 4850 net tons, and 204 ovens per day at Rosedale, using 2800 net tons of coal. Combined coke capacity is set at 2,268,000 net tons per year.

At both coke plants, there is a 40,000-cu ft gas holder, and an extensive piping system connects both coke plants to Franklin, Gautier, Lower, and rod and wire works. At Franklin, three 15,000-cfm, 25-psi gas boosters are now being installed to replace lower pressure boosters.

BLAST FURNACES

Iron and ferromanganese are produced in seven blast furnaces which provide a total capacity of 1,674,000 net tons per year for the two products combined. Two of these furnaces are located at the Lower works and five at the Franklin division. Table I gives dimensional data for all furnaces. All of the furnaces have conventional cooling plates around the hearth, with bosh cooling by copper cooling plates. Copper cooling plates are also installed through the entire inwall section up to the stockline section, where iron castings are built into the brickwork for stockline production.

At Lower works there are two blast furnaces, of 22 ft 8 in. and 18 ft 4 in. hearth diameters, respectively.

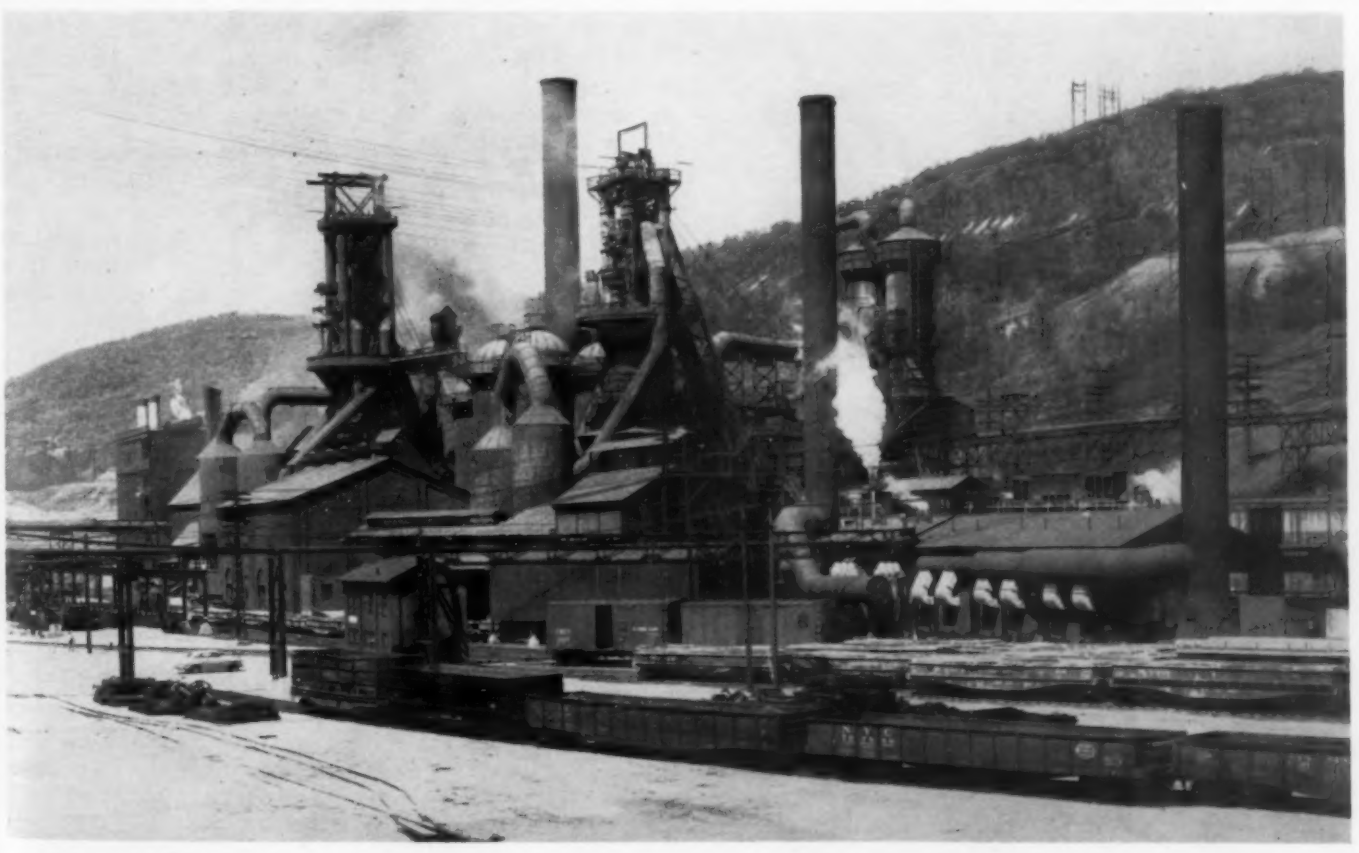


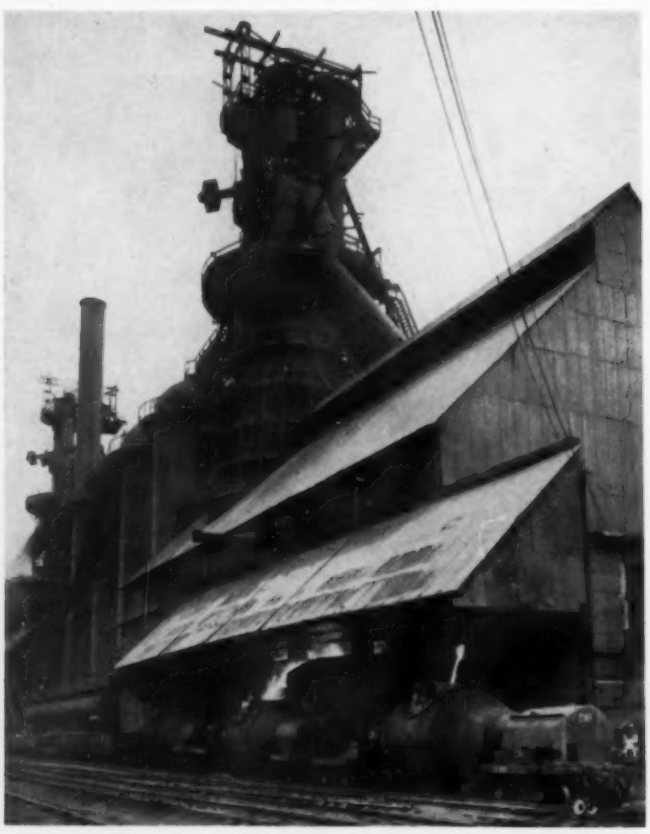
TABLE I

Blast Furnace Proportions

	Lower division		Franklin division				
	E	F	G	H	J	K	L
Diameter of hearth, ft-in.	22-8	18-4	26-0	17-6	21-0	21-0	21-3
Diameter of bosh, ft-in.	26-6	22-0	27-6¾	22-0	23-10	23-6	23-10
Diameter of stockline, ft-in.	19-9	16-0	19-9	16-6	18-0	18-0	18-0
Height of crucible, ft-in.	11-2	9-3	11-7	10-0	10-6	14-0	11-8
Height of bosh, ft-in.	11-3	11-6	10-0	11-9	11-2	11-2	11-10
Height of straight section, ft-in.	11-3	9-3	8-0	8-0	9-6¾	9-6¾	11-6
Height of inwall section, ft-in.	39-4	34-10⅜	43-4	38-4	36-1	36-0	32-3¼
Height of stockline section, ft-in.	10-3¾	11-2	9-8	7-8	12-0	11-3¾	11-11¼
Height, iron notch to top ring, ft-in.	93-1	85-7⅞	94-1	85-11½	89-8	89-7	89-7
Height, bottom to iron notch, ft-in.	2-0	2-0	2-0	2-3	1-6	5-0	1-6
Height, iron notch to cinder notch, ft-in.	4-2	3-8	4-2	3-11	4-0	4-0	4-0
Height, cinder notch to tuyeres, ft-in.	3-0	2-7	3-4	2-10	3-0	3-0	3-0
Bosh angle, deg-min-sec	80-20-0	81-20-51	85-31-58	79-9-35	82-46-11	83-36-46	83-46-50
Inwall batter, in. per ft	1 1/64	1	1 1/16	7/8	1	59/64	1 1/16
Stack working volume, cu ft	33,219	19,573	33,691	19,750	23,852	23,460	24,137
Number of tuyeres	12	12	16	12	12	12	12
Diameter of large bell, ft-in.	14-8	12-0	14-8	12-0	13-0	13-0	13-0
Angle of large bell, deg	53	53	53	53	53	53	53
Thickness of crucible lining, in.	2-5 and 3-0	2-10	2-6 and 3-6	2-11	2-7	2-4	2-4¾
Thickness of bosh lining, in.	1-10½	1-10½	1-10½	1-10½	1-10½	1-10½	1-10½
Thickness of stack lining, in.	3-0	3-0	3-0	2-6	2-9	2-7½	2-6
Thickness of throat lining, in.	2-8⅛	3-2½	3-2½	2-9	2-3	2-3	2-3
Number of hot blast stoves	3	4	4	4	4	4	4
Height of stoves, ft	100	100	100	100	100	100	100
Diameter of stoves, ft	24	24	24	24	24	24	24
Heating surface per stove, sq ft	185,094	125,431	(1) 184,862 (2) 125,452 (1) 126,068	(2) 118,112 (1) 128,114 (1) 126,310	(2) 180,143 (1) 182,465 (1) 185,094	(2) 66,400 (1) 120,068 (1) 126,310	(2) 185,094 (1) 66,400 (1) 126,310

Each furnace is provided with a conventional double skip, with skip cars dumping into a rotating distributor top. All bells are electrically operated except furnace F, which uses steam power. The normal charging cycle is ore, ore, stone, coke, coke, coke. All furnaces use volumetric measurement of coke. Ore and stone are, of course, charged by weight, using conventional electrically driven scale cars.

Franklin works has five blast furnaces, with hearth diameters ranging from 17 ft 6 in. to 26 ft.



At the Lower works, the two furnaces are provided with 37 stock bins for ore, stone and scrap, and two central coke bins. Furnaces G, H and J at Franklin are served by 96 stock bins, each of 1880 cu ft capacity, and a central coke bin at G furnace. Furnaces K and L have 64 bins, also 1880 cu ft in size, and a central coke bin at K furnace.

For the two furnaces at the Lower works, blast is provided by three 2900-hp horizontal cross-compound blowing engines, each rated at 50,000 cfm, operating on 150-psi steam. At Franklin, furnaces G, H and J are blown by two 80,000-cfm blowers driven by 10,650-hp turbines operating on 400-psi steam, and one 45,000-cfm blower driven by a 3000-hp, 165-psi turbine. A 50,000-cfm blowing engine is used as a spare. Furnaces K and L receive blast from two 100,000-cfm blowers, with a 45,000-cfm blower as a spare. Blast pressures at the tuyeres normally range 16–18 psi for iron production and 12–14 psi when making ferromangancse.

Blast is preheated in the stoves which are listed in Table I, with the temperature automatically controlled at the desired level by mixer valves. The stoves are of two-pass design, with six arranged for center combustion and the remainder for side combustion. Checkerwork in the stoves varies considerably in design, with rather wide use of small flues and inserts. Gas, cleaned to a dust content under 0.01 grains per cu ft, is introduced through pressure type proportioning burners. Blast temperatures usually average 900–1000 F on iron production and around 1600 F for ferromanganese.

On all furnaces, gas leaves the top through four off-

takes which are combined into two downcomers. The gas is cleaned by passing through dust catchers in series, washer towers, disintegrators and moisture eliminators. This equipment is listed for the various furnaces in Table II, the arrangement varying somewhat in detail from furnace to furnace. At Franklin division, each downcomer leads into its individual dust catcher, with the discharge from both of these primary units then passing through a third dust catcher. The gas then passes through washing towers and batteries of 40,000-cfm disintegrators.

The gas cleaning system is quite effective, with dust content reduced approximately as follows:

	Dust content of gas, grains per cu ft	
	Iron production	FeMn production
Entering washer tower	3.0	5.0
Entering disintegrator	0.5	1.25
Leaving disintegrator	0.007	0.007

The stoves consume 20–25 per cent of the gas produced on iron production and 25–30 per cent when making ferromanganese. Surplus gas at the Lower division is used as boiler fuel. At Franklin, surplus gas is used for steam generation, for coke oven underfiring, and, mixed with coke oven gas, as fuel for the soaking pits.

TABLE II

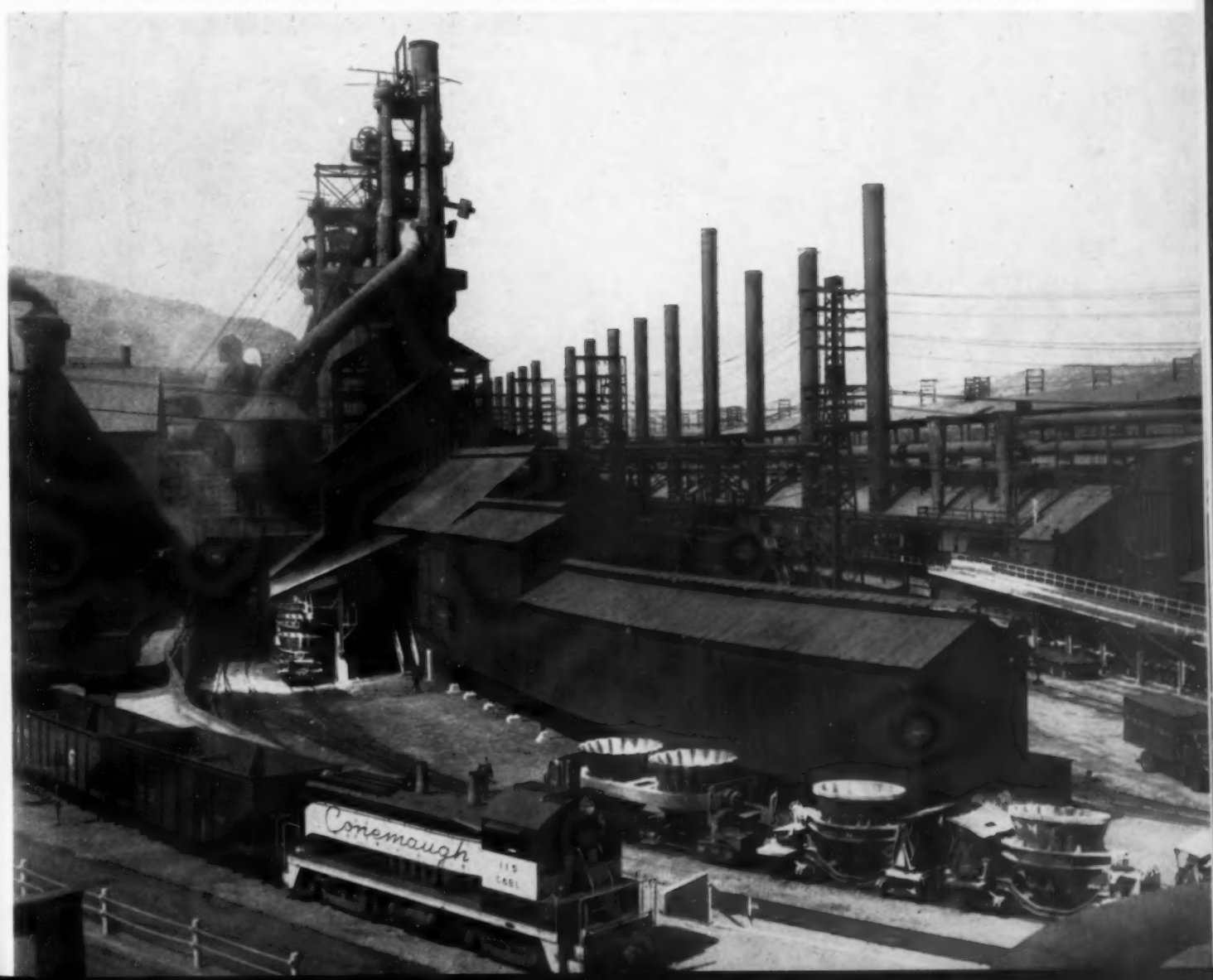
Gas Cleaning Equipment

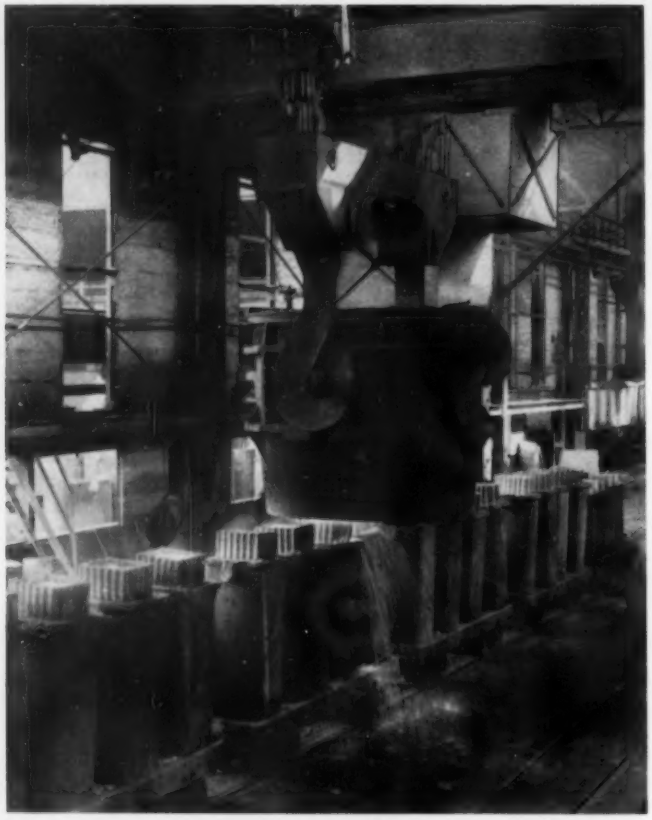
Furnace	No. of dust catchers	No. of washer towers	No. of disintegrators
E	2	2	5
F	2	2	
G	3	2	6
H	3	2	
J	3		
K	3	3	5
L	3		

Gas analyses vary according to the product being made:

	Iron production	Ferro-manganese production
CO_2, per cent	11.0-11.5	4.0- 5.0
CO, per cent	28.0-28.2	36.0-38.0
H_2, per cent	2.0- 2.3	2.5
Btu per cu ft	97 -99	125 -130

The open hearth shop, with 21 furnaces in line, parallels the row of five blast furnaces at Franklin division.





Steel, in a wide range of carbon and alloy grades, is tapped into 175-ton ladles which are handled by new 175-ton ladle cranes.

Normally, four of the Johnstown blast furnaces are kept on the production of basic iron for use in the plant's open hearth division, two furnaces are kept on ferromanganese production, and one furnace may be switched between the two products. Materials charged to the furnaces range approximately as follows:

	Lb per net ton of product	
	Iron production	FeMn production
Iron ore	3120	3800
Limestone	700-800	1380-1600
Scrap	100	30
Open hearth slag	210-290	None
Mill scale	135-400	None
Flue dust	None	90
Coke	1500-1900	3600-4000

The furnaces are tapped every five hours into mixer type ladles for transportation to the open hearth or to the pig casting machines. Analyses of the products average about as follows:

	Per cent	
	Iron	Ferro-manganese
Silicon	0.95-1.25	0.8 - 1.35
Sulphur	0.02-0.05	0.017- 0.026
Phosphorus	0.2 -0.3	0.175- 0.229
Manganese	1.25-1.75	70.0 -80.0

Daily production of iron ranges from 650 net tons per day on the small furnace to 1200 on the largest furnace, while the production of ferromanganese runs 250–325 net tons per day per furnace.

At each blast furnace plant there is a chain type pig casting machine rated at 150 tons per hr.

Slag volume ranges 975–1100 lb per net ton of product on iron production and 1200–1400 lb per net ton of ferro manganese. Slag is taken to two dumps, where some of it is reclaimed and processed for commercial uses.

Slag analyses show the following average:

	Per cent	
	Iron production	FeMn production
SiO_2	34.2	25.4
Al_2O_3	11.3	14.0
CaO	41.0	41.1
MgO	8.6	11.0
S	1.8	2.0
MnO	1.1	4.2

OPEN HEARTH

The open hearth shop of the Johnstown plant, located in Franklin division, is unusual in that it contains 21 furnaces in one line. A modernization program is under way in this department, the furnaces being completely rebuilt from the foundations up. At present, 15 furnaces have been rebuilt to a capacity of 170 net tons per heat, with six remaining to be rebuilt. Present ingot capacity is set at 2,100,000 net tons per year.

As modernized, the furnaces are of two sizes, five having overall brickwork length of 76 ft 4 in. and hearth dimensions of 48 ft 1 in. × 14 ft 6 in., and 16 with overall lengths of 67 ft 4 in. and hearths of 44 ft 3 in. × 14 ft 6 in. The hearths are constructed of 18 in. of magnesite brick backed up by 5 to 11½ in. of rammed subhearth, composed of refractory cement and ground basic brick bats and topped by approximately 12 in. of rammed basic refractory. Basic brick is used for the backwalls, front walls and end walls. The back walls, with the exception of one furnace, are straight and 5 ft 3½ in. high.

Furnace roofs are of sprung arch construction, of silica brick 13½ in. thick with an 18-in. thick section, 3 ft wide along both skewbacks. The central portion of the roof on the longer furnaces is 40 ft 10 in. long and has an arch rise of 3 ft. The sloping section at each end is 9 ft long and has an arch rise of 3 ft and a slope of 2½ in. per ft. It is followed by a straight section at each end, 7 ft 8 in. long, with an arch rise of 3 ft. On the shorter furnaces, the main roof section is also 40 ft 10 in. long, but the roof over the furnace ends is a continuous slope 12 ft 2 in. long, sloping 2½ in. per ft, with an arch rise of 3 ft.

Two downtakes at each end of the furnace, 7 ft 3⅝ in. × 6 ft 1½ in. on the longer furnaces and 5 ft 10 in. × 5 ft 8 in. on the others, lead into a single slag pocket about 14 ft × 15 ft. The fantail provides an opening of 74.3 and 69.0 sq ft area into the regenerators for the two furnace designs.

Regenerator chambers are 28 ft 5½ in. long and about 21 ft in width. Checker work in these chambers is 10 ft 9 in. high, designed with solid flues 5½ in. square.

The furnaces are fired with pitch, bunker C fuel oil

and coke oven gas, in proportions depending on the availability of each. Fuel is introduced through a water-cooled combination burner containing a 3-in. nozzle for gas and a ¾-in. nozzle for oil or pitch. A forced draft fan is provided on each furnace, pushing air for combustion through the regenerators.

Pitch is piped to the open hearth directly from the Franklin coke plant, and is brought in tank cars from the Rosedale plant. It is stored in two 13,000-gal tanks. Fuel oil is received in trucks or in tank cars, pumped to a 500,000-gal storage tank and then to two 13,000-gal tanks. The liquid fuels are moved through separate recirculating systems by two 200-gpm pumps on each system. Steam heaters are installed in each tank and main feed lines are provided with steam tracer lines. Each furnace is also provided with an individual secondary heater for the liquid fuels. Oil temperature is maintained automatically at about 175 F, while pitch is held at a temperature of about 280 F.

Each furnace is equipped with automatic control of combined fuel input, furnace pressure and atomizing steam. The instrument panel also carries recorders on fuel flow, air flow, steam flow and furnace pressure, as well as indicators of gas pressure, air pressure, steam pressure and total fuel input. Fuel consumption runs about 3,750,000 Btu per net ton of ingots produced. Eight of the furnaces are equipped with waste heat boilers, two of which have horizontal fire tubes and six have vertical fire tubes.

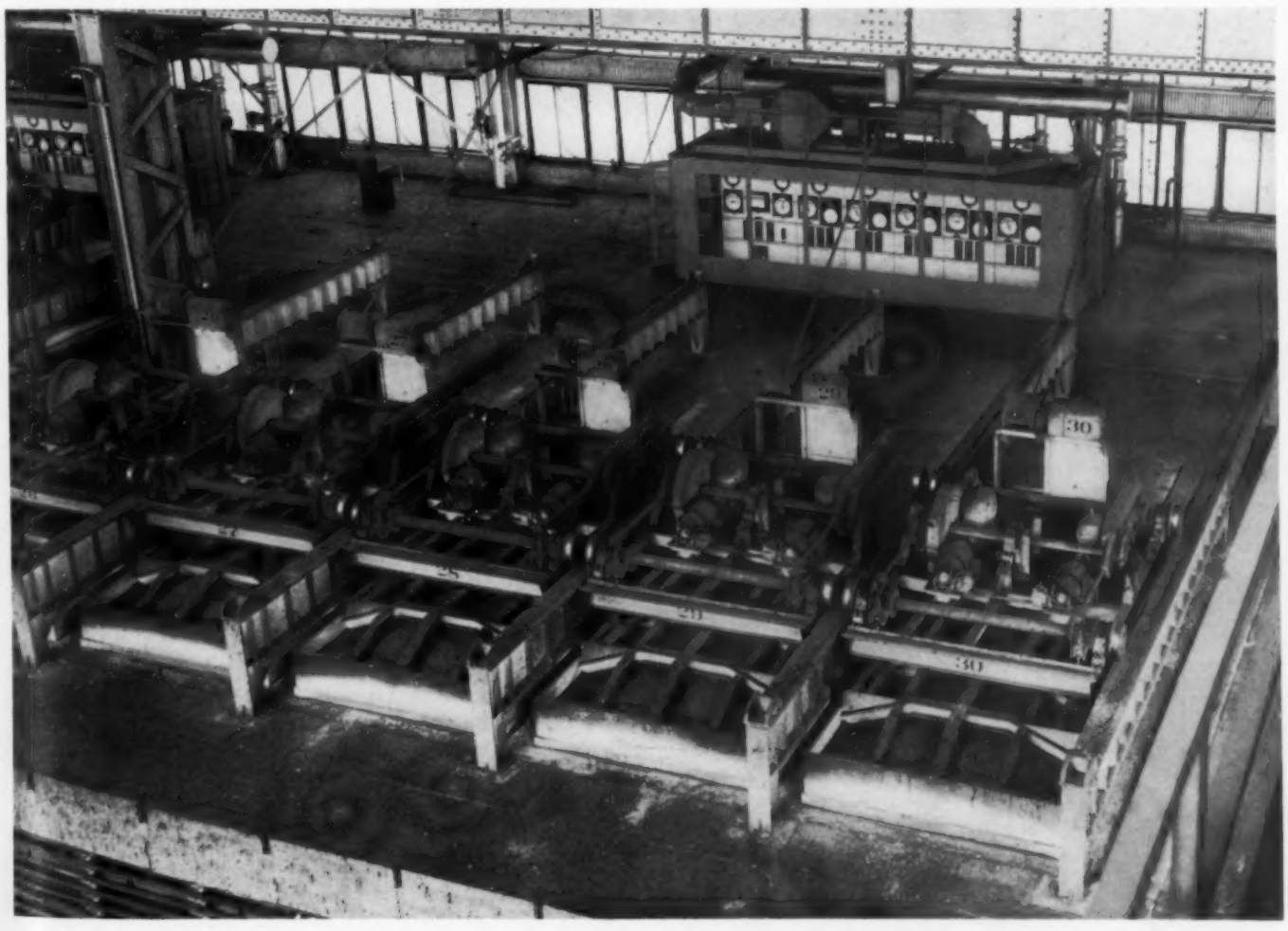
The furnace charge runs about 350,000 lb, and consists of 55–60 per cent of hot metal. Hot metal is brought to the furnace in 61-ton ladles from a 1300-ton hot metal mixer located at the west end of the open hearth building, or from a hot metal station supplied by 200-ton mixer type ladles at the middle of the shop. Additional materials used in the production of steel average 163 lb of fluxes, 7.5 lb of deoxidizers and 18.5 lb of ferroalloys per net ton of ingots produced. The average heat time, tap-to-tap, is 12 hr, giving a production rate of 13.2 net tons per furnace-hour.

A 6-in. oxygen line runs the length of the shop, with drops at each furnace. For decarburization of the heats, oxygen is introduced to the bath through a one-inch pipe immersed about 8 in. into the bath. Oxygen is supplied from a commercial plant located adjacent to the steel plant.

A wide range of plain carbon and low alloy steels (0.05–1.05 per cent carbon) is produced in killed, semi-killed and rimmed grades. The steel is tapped into 175-ton ladles and poured at one of the four pouring platforms into a variety of molds, including the open top corrugated type 22 × 25½ × 78 in., 28½ × 35–40 × 84 in., 25⅝ × 30⅝ × 90 in., 28 × 61–66 × 90 in., and 26⅝ × 42⅝ × 90 in., and the inverted corrugated type 22 × 22 × 73 in., 22 × 25½ × 76–82 in., 28 × 42–61 × 90 in., and 28¾ × 32¾ × 91–97 in. Ingot molds are sprayed with pitch before each use.

Open hearth slag, which runs about 200 lb per ton of

Thirty one-way fired pit furnaces installed in connection with the 46-in. mill may also, through a transfer car, serve the 40-in. bloomer.



The 46-in. bloomer, a two-high, high-lift reversing unit, rolls both slabs and blooms.

ingots produced, is taken to a dump or to a skullcracker where the tap slag is reclaimed for charging into the blast furnaces.

Scrap and some other materials move through an unroofed stockyard, 1500 ft × 80 ft, and served by six 10-ton magnet cranes, lying adjacent to the 1700 ft × 19 ft open hearth lean-to, which houses ferroalloy and flux bins and the furnace controls and panel boards. The charging bay is 1700 ft × 55 ft and contains four 75/25-ton cranes, one 50/25-ton crane, and six 10-ton floor type charging machines. In the pouring bay, 1700 ft long × 48 ft wide, are four 175-ton ladle cranes with 35-ton auxiliary hoists, and two 150-ton ladle cranes with 25-ton auxiliary hoists. Running along the pouring bay is a mold yard 1400 ft × 82 ft, served by four cranes, three rated at 25/15 tons, and one at 10 tons.

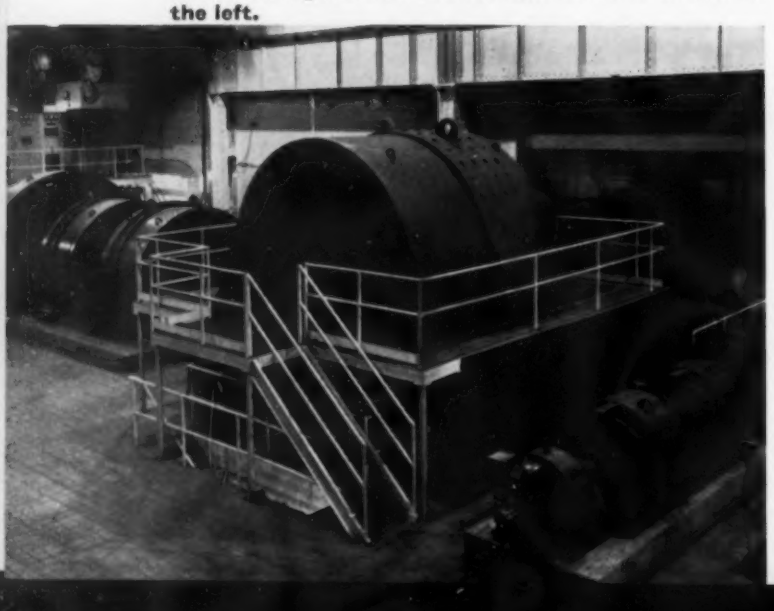
There are two stripper buildings, one near the end of the open hearth buildings containing two 400-ton strippers and one 200-ton unit, and one near the soaking pits, housing a 200-ton stripper.

BLOOMING AND BILLET MILLS

The Franklin division has two blooming mills, a 40-in. unit installed in 1901 and later modernized and electrified, and a 46-in. unit installed in 1951.

The 40-in. mill is a two-high reversing unit driven through 18-in. spindles by a 5000-hp, 75-120-rpm, 700-volt d-c shunt motor which develops a torque of 1,000,000 ft-lb. This motor receives power from a motor-generator set consisting of two 2100-kw, 700-volt d-c generators and a 177-in. flywheel, driven by a 3200-hp 6600-volt, 367-rpm induction motor. Mill pinions, of 43¾ in. face, have herringbone teeth of 6.981-in. circular pitch, operating in babbitted bearings.

The 46-in. mill is driven by an 8000-hp twin-motor drive. The motor-generator set for this drive is shown at the left.



The mill rolls, with bodies 74 in. long and 34 in. in diameter, are made of alloy steel and carry 8 in. and 16½ in. passes and a 36¾ in. bullhead. They run in composition bearings. The top roll, which is hydraulically balanced, is raised and lowered at a speed of about 13 fpm by two 10-in. screws of 1¾ in. pitch, driven by two 70-hp, 250-volt d-c motors in parallel under magnetic control.

Ingots, brought to the mill by pit cranes or by transfer car from the 46-in. mill pits, are manipulated during rolling by two hydraulically operated side guards in front of the mill.

Heating facilities for the 40-in. mill consist of five rows of regenerative pits, each row of four holes 9 ft 6 in. long × 5 ft 6 in. wide × 10 ft 6 in. deep. They are fired with mixed coke gas and blast furnace gas of 175-195 Btu per cu ft, introduced through 6-in. pipes in each end wall above the checkers. The pits are served by two 10-ton pit cranes of 64 ft 11 in. span.

In line with the 40-in. mill at a distance of 132 ft is a hydraulically operated shear capable of cutting sections up to 6 in. × 20 in. and 14 in. × 14 in. The shear runout table leads on to a 34-in. billet mill. This unit is a single stand, two-high reversing mill, driven at speeds up to 140 rpm by a 4500-hp, 46 in. × 60-in. condensing steam engine. The top roll is moved by screws 12 in. in diameter, motivated by two 70-hp, d-c motors. The rolls are 31 in. in diameter, with a body length of 69¼ in. They operate in composition bearings.

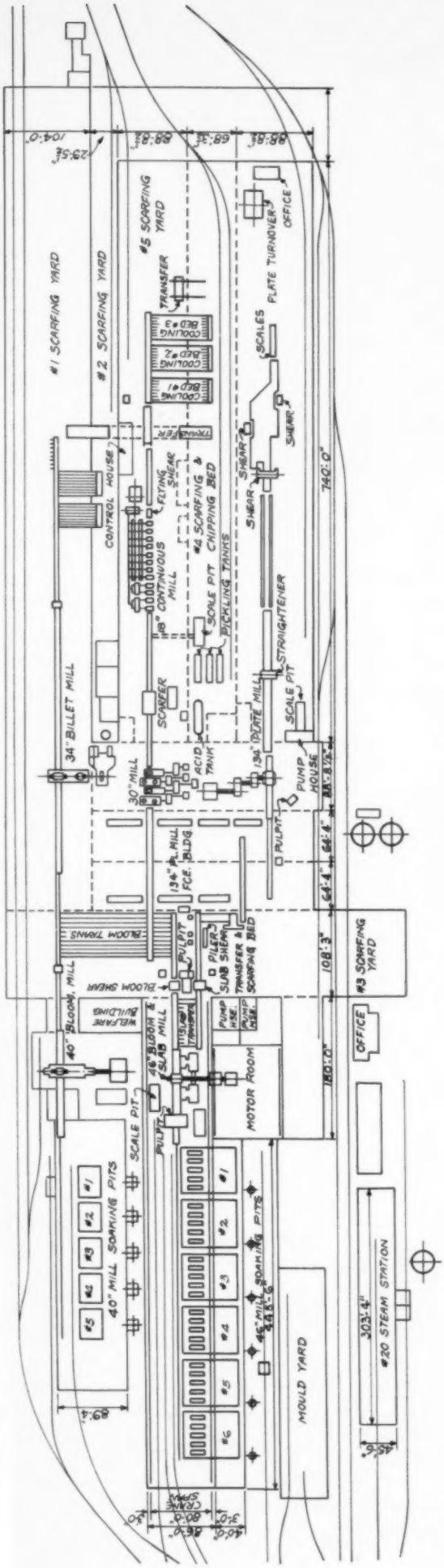
The 34-in. mill takes blooms from the 40-in. bloomer and reduces them to billets from 3 × 4 in. to 8 × 14 in., slabs from 3 × 6 in. to 7½ × 15 in., and rounds 7½–15 in. in diameter, at rolling rates averaging about 82 tons per hr. Large rounds from this mill, used for blanks for the wheel mills, are torch-cut to the desired length.

Some 200 ft beyond the 34-in. mill is a steam-hydraulic shear capable of cutting sections up to 16 × 10 in., and further on, two cooling beds 28 ft × 58 ft, with the necessary pushers, kick-offs and cradles.

For the new 46-in. mill, ingots are heated in six rows of one-way fired pits, each row made up of five holes, 20 ft 6 in. long × 7 ft 6 in. wide × 13 ft 3 in. deep. Each block is provided with two recuperators in series, one of tile construction and one of metallic tube design. Air for combustion is preheated to about 1300 F. Mixed coke gas and blast furnace gas of 130 Btu per cu ft is introduced through venturi burners in one end wall. These pits are equipped with automatic control on temperature, fuel-air ratio and furnace pressure.

Ingots are handled into and out of the pits by three 20-ton pit cranes of 80-ft span with telescopic masts. The heated ingot is placed in an ingot buggy which conveys it to the 46-in. mill approach table. Ingots from the new pits may also be carried on a transfer car for rolling on the 40-in. bloomer.

The 46-in. mill is a two-high, high-lift reversing unit, driven through 21-in. spindles by a twin-motor drive consisting of two 4000-hp, 40-100-rpm, 800-volt, d-c



Layout of Franklin rolling mills.

compound motors. This drive, which develops a maximum torque of 1,180,000 ft lb, receives power from a motor-generator set composed of two 3500-kw, 800-volt d-c generators, a 176,000-lb flywheel, and a 6000-hp, 370-rpm, 6600-volt induction motor. The drive is controlled by rotating regulators.

Mill rolls are 44¾ in. in diameter and have a body length of 114 in. Of alloy steel, they are designed with passes of 6, 12 and 16 in. width, and a bullhead 63⅝ in. wide. Composition bearings are applied on the top roll necks, and babbitted bearings with bronze collar and inserts on the bottom roll necks. The top roll, which is balanced mechanically by levers and counterweights, is moved up and down at speeds up to 160 in. per min through the action of two 16-in. screws of 2-in. pitch, driven by two 150-hp, 460-rpm, 230-volt d-c motors under adjustable voltage control.

Sideguards, 28 ft 8 in. long, are provided in front and in back of the mill. They are operated at speeds up to 50.6 in. per sec by two 150-hp d-c motors in series on each sideguard, under adjustable voltage control. One sideguard of each pair is equipped with four manipulator fingers driven by a 150-hp d-c shunt motor.

Adjustable voltage control is also applied to the front and back mill tables. Power for the various auxiliaries so controlled comes from two motor-generator sets, each consisting of five 625-kw, 90-250-volt d-c generators, driven by a 700-hp, 750-rpm, 6600-volt synchronous motor.

A hydraulically operated bloom shear capable of cutting sections up to 20 in. × 20 in. is placed 123 ft after the 46-in. mill. Located beside the bloom shear, in a parallel table line connected to the 46-in. mill runout by a slab transfer, is a hydraulically operated slab shear with a capacity for a 15½ in. × 59-in. section. From this shear, slabs are carried over a transfer to a scarfing yard adjacent to the 134-in. plate mill, or directly to the plate mill furnaces.

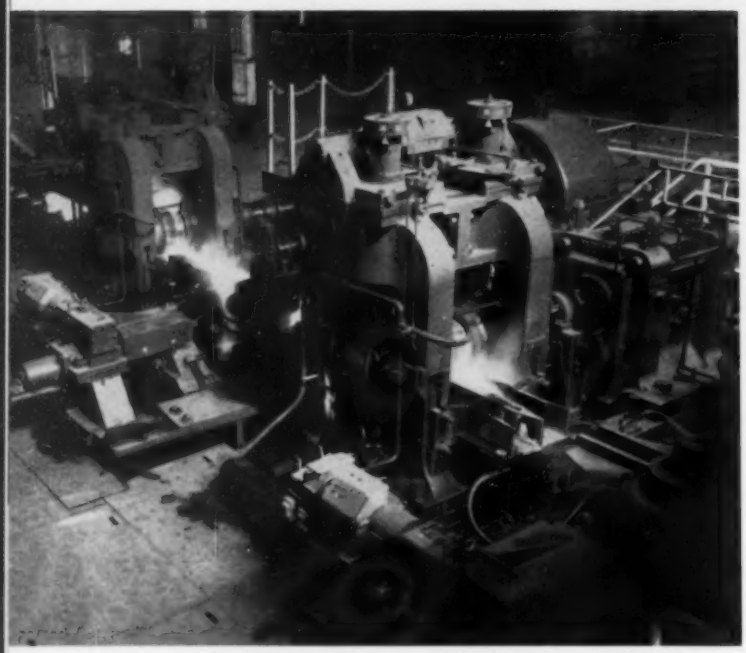
The 40-in. mill operates at rolling speeds up to 1070 fpm and averages about 107 tons per hr. The 46-in. mill, which will run up to 1150 fpm, averages about 250 tons per hr.

Sizes from the 40-in. mill may include 8 × 6 in., 8 × 8 in., 8 × 16 in., 10 × 16 in., 12 × 16 in. and 17 × 16 in. The 46-in. mill turns out blooms 8 × 12 in., 10 × 12 in., 12 × 12 in., 8 × 16 in., 10 × 16 in., 12 × 16 in., and 17 × 16 in., as well as slabs ranging from 3½ × 17 in. up to 15½ x 58½ in. The combined rolling of both mills includes about 75 per cent blooms and 25 per cent slabs.

The two mills parallel each other, approximately 150 ft apart. The runout tables from the bloom shear on each mill are connected by a bloom transfer which also crosses the approach table to the 30-in. and the 18-in. mills, thus forming a very flexible rolling arrangement.

The 30-in. billet mill consists of four stands, two with vertical rolls, 43 in. in diameter × 19¾ in. body length, alternated with two two-high stands with rolls 30⅞ in. in diameter × 38 in. body length. Rolls in the vertical stands are adjusted by two 35/45-hp, 250-volt d-c motors, while a single motor of the same rating adjusts the rolls in the horizontal stands.

Each stand is driven through a gear set and pinions by a 750-hp, 284-rpm, 6600-volt a-c induction motor.



The 30-in. mill, with two vertical and two horizontal roll stands, usually produces 8⅛-in. rounds for axle production and for further rerolling into square billets.

Mill speeds are as follows:

Stand	Type	Distance from preceding stand, ft	Roll rpm	Speed, fpm
1	Vertical	..	6.2	55.2
2	2-high	12	12.25	69.75
3	Vertical	10	9.86	91.08
4	2-high	12	18.18	111.85

Roll necks operate in babbitt bearings with brass inserts, and babbitt bearings are applied on the pinions and gear set.

Round or square blooms from the 30-in. mill pass through this oxyacetylene scarfing machine and proceed to the 18-in. mill.

From the 30-in. mill, billets proceed over a table approximately 225 ft long to the 18-in. continuous mill. Installed in this table is an automatic scarfing machine, designed to scarf 8 in. × 8 in. squares, or with a change in the torch gear, 7½ to 8⅛-in. rounds.

The 18-in. mill consists of 12 two-high stands placed on centers of approximately 10 ft. The five roughing stands have rolls 21 in. in diameter × 34 in. body length, while the seven finishing stands have 18 in. × 27-in. rolls. Steel rolls are used in the first nine stands, with alloy iron in the last three. The entire mill is driven through line shaft and gears by a single 5500-hp, 370-rpm, 6600-volt a-c induction motor, giving mill speeds as follows:

Stand	Roll, rpm	Speed, fpm
1	8.12	44.6
2	9.95	54.7
3	11.38	62.5
4	14.63	80.4
5	21.22	116.7
6	27.6	130.1
7	32.0	150.8
8	39.7	187.1
9	48.0	226.2
10	67.7	319.0
11	90.7	427.4
12	126.5	596.1

All roll necks, pinions and gears run in babbitted bearings.

Power consumption of the 18-in. mill averages 30.8 kwhr per ton for the main drive and 1.1 kwhr per ton for auxiliaries.

Immediately following the last stand is a steam-operated, electrically controlled flying shear capable of cutting sections up to 5 × 5 in. At the end of the shear runout are three cooling beds, 30 ft × 62 ft 5¾ in.

The 30-in. mill takes blooms 12 × 12 in., normally from the 46-in. bloomer, and reduces them to 8 × 8 in. squares or 8⅛-in. rounds. These sections are then reduced in the 18-in. mill to 4 ×4 in., 3¼ × 3¼ in., 2½ × 2½ in., or 1¾ × 1¾ in. The 8-in. rounds produced on the 30-in. mill are used in the production of forged axles. To save roll changing time, the 18-in. mill has been set up to take 8⅛-in. rounds from the 30-in. mill for rolling down into the smaller square billets. This use of a round for further re-rolling seems to improve surface quality of the final billets. The billet mill combination rolls at a production rate averaging about 85 tons per hr.

In all of the blooming and billet mills, mill scale drops beneath the tables and is flushed into scale pits which are periodically unloaded by grab buckets.

PLATE MILLS

Sheared plate is rolled from slabs from the 46-in. mill in the 134-in. plate mill, which is located near the end of the bloomer. The slabs are heated in seven batch type regenerative furnaces with hearths 30 ft long × 8 ft wide. The furnaces are fixed with coke gas or fuel oil, fuel consumption running 1,760,000 Btu per ton of slabs. Slabs are charged and drawn by four overhead charging machines.

This 18-in. continuous mill is set up to produce billets 1¾-4 in. square from 8⅛ in. diameter rounds.

The mill is a single three-high 134-in. stand, with top and bottom rolls of 36-in. diameter and a 22-in. middle roll. Brass and babbitt bearings are applied on the roll necks. The rolls are hydraulically balanced, with the middle roll being shifted up and down by hydraulic jacks. Rolls are adjusted by four screws of 14½-in. diameter and 2½-in. pitch, operated by one 60-hp d-c motor. The maximum roll opening is 15½ in.

The mill is driven through a 1:5:33 ratio reduction gear and pinions by a 5500-hp, 370-rpm, 6600-volt a-c induction motor which develops a torque of 220,000 ft-lb at full load. Between the motor and the reduction gear is a cast steel flywheel of 10-ft diameter and 2-ft face. The mill operated at 72 rpm, which gives a plate speed of 678 fpm. Salt and water jets at 500-psi pressure is used to remove scale from the slabs. The scale falls beneath the mill tables and is washed into a pit, from which it is removed by a grab bucket.

The approach table to the mill, 127 ft 8 in. long, is driven by two 50-hp d-c motors. The entry table and the delivery table, both about 25 ft long, are each driven by two motors and are tilted by hydraulic jacks.

Following the mill at a distance of about 130 ft is a nine-roll leveler driven by a 100-hp d-c motor. At the end of the mill run-out is a caster bed equipped with three hydraulic shears capable of cutting up to 1¾ in. × 124 in.

The 134-in. mill produces plate up to 124 in. wide in thicknesses ranging 3/16 to 4⅞ in. from slabs running from 34 in. × 3½ in. to 58 in. × 15½ in., and up to 78 in. in length. The average rolling rate is 28 tons per hr. Power consumption averages 25.8 kwhr per ton for the main drive, and 7.6 kwhr per ton for the mill auxiliaries.

At the Gautier division there is another plate mill, a 36-in. universal unit, which reduces slabs ranging from 6 in. × 3 in. × 3 ft to 36 in. × 6 in. × 11 ft 6 in. down to plate 6/16 in. to 36 in. wide and ¼ to 3 in. thick.

Slabs are heated for rolling in two continuous, end-charge, side-discharge furnaces with hearths 52 ft long × 12 ft wide. At the charging end of the furnaces, slabs are piled on hoists which raise the pallets of slabs so that a hydraulic pusher can move a layer of slabs into the furnace. After the slab has progressed through the furnace, a motor-operated pusher expels it to a roller table running under the discharge ends of the furnaces.

The furnaces are fired with coke gas, and are equipped with automatic control on gas pressure, gas-air ratio and furnace pressure.

Mill tables carry the heated slab to the roughing stand, a 25 in. × 67-in. reversing two-high stand with integral vertical rolls of 14¾ in. diameter and 12½ in. face on each side of the mill. This stand is driven at speeds up to 125 rpm by a 2500-hp, 36 in. × 36-in., three-cylinder steam engine. Vertical rolls are driven off of the main drive shaft from the pinion housing. Horizontal rolls are adjusted by 6-in. screws driven by a 30-hp motor, and each set of vertical rolls are adjusted by 4-in. screws driven by a 35-hp motor. Horizontal rolls open to a maximum distance of 6½ in., vertical rolls to 37 in.

From the rougher, the plate proceeds down the run-out table, through the first finishing stand, over a drag-over type transfer 90 ft wide to a parallel mill line in the adjacent building bay, and back through the second finishing stand. Both finishing stands are 25 in. × 57-in. two-high units and are driven on a common shaft by a single 1800-hp, 75-rpm, 2200-volt induction motor.

Leaving the mill, the plate passes over a roller table, through a nine-roll leveler, and then across a drag-over type hot bed 95 ft wide into another adjacent building bay. At the end of the cold runout table is a motor-driven shear capable of cutting sections up to 36 in. × 1 in. From the shear, another runout leads to a piler and scales.

Roughing rolls operate in babbitted bearings, and the vertical rolls in brass bearings, all lubricated by an automatic grease lubricating system. Roll neck bearings on the finishing stands are composition, water lubricated.

Scale is removed from steel passing through the mill by the use of salt and by water sprays of 1200 and 500-psi pressure.

The mill rolls at an average rate of 18 tons per hr.

This 9-in. mill is one of nine merchant mills at Gautier division. The finishing stand is at the right, while the beginning of the cooling bed is at the lower left.

MERCHANT MILLS

In addition to the universal plate mill just discussed, Gautier division includes all of the merchant mills of the plant, a total of nine, of various types ranging 8–14 in. in nominal size. Details of these units are as follows:

8-in. No. 1 mill

One continuous furnace, end charge, side discharge, 10 ft × 22 ft. Fired with coke gas.

One roughing stand, driven by a 300-hp, 365-rpm, 2200-volt induction motor.

Five finishing stands, side by side, driven by one 500-hp, 365-rpm, 2200-volt induction motor.

Stand No.	Type	Roll dimensions, in.	Roll rpm	Speed, fpm
1	3-high	10½ x 30	226.5	622.3
2	3-high	8½ x 24	365	311.4
3	3-high	8 x 18	365	763.3
4	3-high	8 x 18	365	763.3
5	2-high	8 x 10	365	763.3
6	2-high	8 x 10	365	763.3

Babbitted bearings on all roll necks, gear set and pinions.

Steam-operated stretcher on run-out from No. 6 stand.

Hot bed 130 ft 6 in. × 12 ft 5¼ in., hand drag-over.

Motor-driven alligator shear, to cut two 1 in. × ½ in. flats.

Reel to make bundles 18, 24, 26 or 30-in. inside diameter. Bundles up to 25 lb.

Billets used — 1 × 1 in., 1¼ × 1¼ in., 1¾ × 1¾ in., 2 ft to 9 ft 8 in. long.

Products — Small angles, channels and tees, sharp and round edge flats, ovals and half ovals and various lock washer stock, ranging 0.106–1.91 lb per ft.

Average rolling rate — 2.1 net tons per hr.

Power consumption — 104.2 kwhr per ton for main drive, 6.5 kwhr for auxiliaries.

8-in. No. 2 mill

One continuous furnace, end charge, side discharge, 10 ft × 22 ft. Fired with coke gas.

One roughing stand, driven by a 300-hp, 365-rpm, 2200-volt induction motor.

Five finishing stands, side by side, driven by one 300-hp, 365-rpm, 2200-volt induction motor.

Stand No.	Type	Roll dimensions, in.	Roll rpm	Speed, fpm
1	3-high	12 x 36	204.5	642.13
2	3-high	8½ x 24	375	833.63
3	3-high	8 x 18	375	785.40
4	3-high	8 x 18	375	785.40
5	2-high	8 x 10	375	785.40
6	2-high	8 x 10	375	785.40

Babbitted bearings on all pinions, and on the roll necks of stands No. 2, 3, 4 and 5. Composition bearings on No. 1 and 6 roll necks.

Steam-operated stretcher on run-out from No. 6 stand.

Hot bed 130 ft 6 in. × 13 ft, hand drag over.

Motor-driven alligator shear, to cut two 1 in. × ½ in. flats.

Reel to make bundles 18, 24, 26 or 30 in. inside diameter. Bundles up to 98 lb.

Billets used — 1 × 1 in., 1¼ x 1¼ in., 1¾ × 1¾ in., 2 ft to 9 ft 8 in. long.

Products — Small flats, bands, squares and miscellaneous shapes ranging 0.32–1.43 lb per ft.

Average rolling rate — 2.8 net tons per hr.

Power consumption — 87.1 kwhr per ton for main drive, 7.3 kwhr for auxiliaries.

9-in. No. 1 mill

One continuous furnace, end charge, side discharge, 13 ft × 20 ft. Fired with coke gas.

Two roughing stands and four finishing stands, side by side, driven by one 1000-hp, 293-rpm, 6600-volt induction motor.

Stand No.	Type	Roll dimensions, in.	Roll, rpm	Speed, fpm
1	3-high	9 x 28	293	690.2
2	3-high	9 x 28	293	690.2
3	3-high	9 x 21	293	690.2
4	3-high	9 x 21	293	690.2
5	2-high	9 x 11	293	690.2
6	2-high	9 x 11	293	690.2

Babbitted bearings on all pinions and on roll necks of stands No. 2, 3, 4 and 5. Composition bearings on No. 1 and 6 roll necks.

Steam-operated stretcher on run-out from No. 6 stand.

Hot bed 122 ft × 15 ft 9 in., hand drag-over.

Motor-driven shear, to cut up to 1-in. × 1⅜ in. stock.

Billets used — 1¾ × 1¾ in. and 2½ in. × 2½ in., up to 12 ft 2 in. long.

Product — Angles, channels and tees, square edge and round edge flats, ovals and half-ovals, and miscellaneous sections ranging 0.448–5.95 lb per ft.

Average rolling rate — 3 net tons per hr.

Power consumption — 62.5 kwhr per ton for main drive, 8.4 kwhr for auxiliaries.

9-in. No. 2 mill

One continuous furnace, end charge, side discharge, 17 ft × 25 ft. Fired with coke gas.

Four roughing stands in tandem, arranged in two pairs, all driven by one 1000-hp, 200-480-rpm, 250-volt d-c motor.

Five finishing stands, side by side, the first four driven by one 1000-hp, 200-480-rpm, d-c motor, and the last stand by a 500-hp, 250-600-rpm d-c motor, both of 250 volts.

Stand No.	Type	Roll dimensions, in.	Roll, rpm	Speed, fpm
1	2-high	12 x 27	40- 96	286.57
2	2-high	12 x 27	60-144	450.63
3	2-high	12 x 27	87-209	655.59
4	2-high	12 x 27	125-300	939.09
5	3-high	9 x 18	200-480	1131.07
6	3-high	9 x 18	200-480	1131.07
7	3-high	9 x 18	200-480	1131.07
8	2-high	9 x 18	200-480	1131.07
9	2-high	9 x 18	250-600	1418.0

Composition bearings on roll necks; babbitted bearings on gears and pinions.

Hot bed 220 ft × 11 ft, shuffle type.

Motor-driven billet shear, to cut up to 2½ in. squares, at charging end of furnace. Motor-driven shear after hot bed, to cut up to four 2 × 2 × ¼ in. angles.

Billets used — 1¾ in. × 1¾ in. and 2½ in. × 2½ in., in lengths of 6 ft to 15 ft 3 in.

Product — Angles, channels and tees, square edge and round edge flats, and miscellaneous sections, ranging 0.43–5.3 lb per ft; strip 1 in. × ⅛ in. up to 3½ in. × ⅜ in.

Average rolling rate — 7.1 net tons per hr.

Power consumption — 35.7 kwhr per ton for main drive, 6.8 kwhr for auxiliaries.

9-in. No. 3 mill

One continuous furnace, end charge, side discharge, 27 ft × 31 ft. Fired with coke gas.

Eight 2-high stands, arranged with three on 4 ft 6 in. centers, followed by one 35 ft away, then another 79 ft farther. The steel is then reversed back through two stands, and reversed again to pass through the last stand. Stands No. 1, 2, 3, 4, 7 and 8 are driven through gears by one 1000-hp, 360-rpm, 2200-volt induction motor. Stands No. 5 and 6 are driven by an 800-hp, 360-rpm, 2200-volt induction motor.

Stand No.	Roll dimensions, in.	Roll, rpm	Speed, fpm
1	10 x 14	35	91.56
2	10 x 14	50	130.80
3	10 x 14	80	209.28
4	10 x 14	100	261.60
5	10 x 20	360	941.67
6	10 x 20	360	941.67
7	9 x 11	360	848.16
8	9 x 11	398	937.69

Composition bearings on roll necks; babbitted bearings on gears and pinions.

Hot bed 130 ft × 13 ft 6 in., saw tooth type.

Motor-driven hot shear, to cut up to 2½ in. square, at furnace exit. Motor driven cold shear at end of cooling bed, to cut up to 2½ in. × ¾ in.

Billets used — 1¾ in. × 1¾ in., 2½ in. × 2½ in., 30 ft long.

Product — Square edge and round edge flats, automotive leaf spring stock and nut flats, ranging 0.745–5.75 lb per ft.

Average rolling rate — 9.6 net tons per hr.

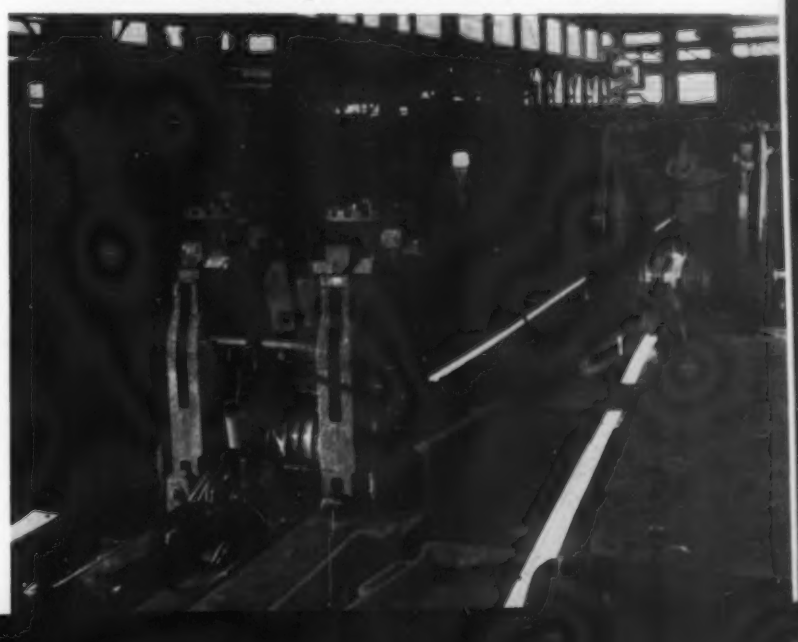
Power consumption — 40.9 kwhr per ton for main drive, 5.2 kwhr for auxiliaries.

10-in. mill

One continuous furnace, side charge, side discharge, 30 ft × 30 ft. Fired with coke gas.

Ten 2-high stands, arranged with four on 4-ft centers, followed by one 30 ft away. Five stands arranged for looping between stands. Stands No. 1, 2, 3 and 4 are driven by two motors coupled together, rated 1000-2000-hp, 200-400 or 400-600 rpm. Stands No. 5, 6, 7 and 8 are driven by two motors coupled together and rated

Finishing stand (left) and leader stand (right) of 14-in. merchant mill, the largest mill at Gautier division.



at 1700-hp, 200-500 rpm. Stands No. 9 and 10 are driven by one 900-hp, 425-640 rpm motor. All of the motors are compound wound 250-volt d-c units.

Stand No.	Roll dimensions, in.	Roll, rpm	Speed, fpm
1	12 x 27	23.13- 69.39	250.91
2	12 x 27	35.81-107.44	386.92
3	12 x 27	51.06-153.18	551.25
4	12 x 27	64.02-192.61	695.86
5	10 x 20	167.91-335.82	788.80
6	10 x 20	184.62-369.23	868.13
7	10 x 20	206.90-431.79	972.33
8	10 x 20	226.85-453.70	1066.05
9	8½ x 13	425 -640	1340.80
10	9½ x 13	425 -640	1507.97

Composition bearings on roll necks; babbitted bearings on gears and pinions.

Hot bed 330 ft × 11 ft 6 in., saw tooth type.

Hot shear at furnace exit, driven from roughing drive, to cut up to 3-in. squares. Motor-driven cold shear after hot bed, to cut up to 2¼ in. diameter. Motor-driven flying shear ahead of hot bed, to cut up to ¾ in. × 2 in.

Four pouring reels, in two sets of two reels. One set forms coils 28-in. inside diameter, the other, 34-in. inside diameter.

Billets used — 1¾ in. × 1¾ in., 2½ in. × 2½ in., 30 ft long.

Product — Rounds ⅜ to 1 31/32 in., squares ⅜ to ⅞ in., hexagons ⅜ to 1 in., reinforcing bar, No. 3–8, and miscellaneous sections, ranging 0.376–2.94 lb per ft.

Average rolling rate — 18 net tons per hr.

Power consumption — 42.4 kwhr per ton for main drive, 4.1 kwhr for auxiliaries.

12-in. mill

One continuous furnace, end charge, side discharge, 13 ft × 40 ft 6 in. Fired with coke gas.

Five stands, side by side, driven by one 1200-hp, 490-rpm, 6600-volt induction motor.

Stand No.	Type	Roll dimensions, in.	Roll, rpm	Speed, fpm
1	3-high.....	12 x 36	112	351.86
2	3-high.....	12 x 32	112	351.86
3	3-high.....	12 x 32	112	351.86
4	3-high.....	12 x 24	112	351.86
5	2-high.....	12 x 24	112	351.86

Composition bearings on roll necks of last stand; babbitted bearings on all other roll necks, as well as on gears and pinions.

Hot bed 67 ft 6 in. × 27 ft 9⅝ in., hand drag-over type.

Motor-driven cold shear at end of hot bed, to cut up to 5 in. × 1 3/16 in.

Billets used — 2½ × 2½ in., 3¼ × 3¼ in., 4 × 3 in., 4 × 4 in., 5 × 3 in.

Product — Round-cornered squares, nut stock, tees, brake beams, rail clips, sash, automobile rim sections and miscellaneous shapes, ranging 1.45–13.80 lb per ft.

Average rolling rate — 4.7 net tons per hr.

Power consumption — 51.2 kwhr per ton for main drive, 2.9 kwhr for auxiliaries.

13-in. mill

One continuous furnace, side charge, side discharge, 32 ft × 64 ft. Fired with coke gas.

Five 2-high roughing stands in tandem spaced 40, 60, 83.5 and 100 ft apart successively. Two 2-high

A wide range of wire, from No. 36 gage up to 1-in. diameter, is drawn at the rod and wire division.

finishing stands 125 ft apart in tandem line parallel to roughing train. Three more 2-high finishing stands, side by side. The first eight stands are driven by two 1500-hp, 150-300 rpm motors coupled together. The last two stands are driven by one 1500-hp, 150–300 rpm motor. All of these drives are compound wound 250-volt d-c units.

Stand No.	Roll dimensions, in.	Roll, rpm	Speed, fpm
1	18 x 40½	15 - 30	141.7
2	18 x 40½	25 - 50	235.62
3	18 x 40½	35 - 70	329.86
4	18 x 40½	50 -100	471.24
5	18 x 40½	62.7-125.4	590.93
6	14 x 24	90 -180	661.62
7	14 x 24	110.5-221	812.32
8	14 x 24	120 -240	883.05
9	14 x 24	136 -272	1000.14
10	14 x 24	150 -300	1102.70

Composition bearings on roll necks of roughing stands and No. 10 stand; babbitted bearings on No. 6–9 stands, and on gears and pinions.

Hot bed 190 ft × 24 ft, sawtooth type.

Motor-driven hot shear at furnace exit, to cut up to 6-in. squares. Motor-driven cold shear after hot bed to cut up to 8 in. × 2½ in.

Billets used — 2½ in. to 6 in. squares, 30 ft long.

Product — Rounds 1 1/32 to 3 in., squares 15/16 to 2½ in., hexagons 1 1/16 to 2 1/16 in., round edge and square edge flats, reinforcing bars No. 8–11, automotive leaf spring flats, and miscellaneous sections, ranging 1.9–34.0 lb per ft.

Average rolling rate — 24 net tons per hr.

Power consumption — 40.4 kwhr per ton for main drive, 7.8 kwhr for auxiliaries.

14-in. mill

One continuous furnace, side charge, side discharge, 32 ft × 57 ft. Fired with coke gas.

Five 2-high roughing stands in tandem, spaced 40, 60, 83.5 and 107 ft apart respectively. Three 2-high finishing stands are arranged side by side, followed by one stand 154 ft away, with the last stand beside it. Chain transfers connect the mill lines between stands No. 5 and 6, and between stands No. 9 and 10. Stands No. 1, 2, 3, 4, 5, 6, 9 and 10 are driven by two 1500-hp, 150–300 rpm motors coupled together, while stands No. 7 and 8 are driven by one 1500-hp, 150–300 rpm motor. All three motors are compound wound 250-volt d-c units.

Stand No.	Roll dimensions, in.	Roll, rpm	Speed, fpm
1	18 x 40½	15 - 30	141.37
2	18 x 40½	25 - 50	235.62
3	18 x 40½	35 - 70	329.86
4	18 x 40½	50 -100	471.24
5	18 x 40½	62.7-125.4	590.93
6	14 x 31½	90 -180	659.73
7	14 x 31½	110.5-221	810.0
8	14 x 31½	120 -240	879.64
9	14 x 31½	135 -270	989.60
10	14 x 24	150 -300	1099.56

Composition bearings are applied to all roll necks; babbitted bearings to all gears and pinions.

Two hot beds, one 197 ft 4 in. × 40 ft, followed by another 176 ft × 40 ft. One 8-roll straightener located between the two beds.

The rod and wire division includes 14 machines for producing various types of wire fencing.

Motor-driven hot shear at furnace exit, to cut up to 6-in. squares. Two hot saws, 30 ft apart, after No. 10 stand. Two motor-driven cold shears at end of last hot bed, to cut up to 8 in. × 2½ in.

Billets used — 3¼ to 9½ squares, 30 ft long.

Product — Rounds 3 to 8 in., flats from 3½ × 7/32 in. to 6 in. × 2½ in., rail 25 to 45 lb per ft, angles, tees, zees, automobile rim stock, automotive leaf spring flats, and miscellaneous shapes, ranging 1.65–170.9 lb per ft.

Average rolling rate — 23 net tons per hr.

Power consumption — 30.4 kwhr per ton for main drive, 9.0 kwhr for auxiliaries.

These mills combine to provide an annual rolling capacity of about 900,000 tons of a widely diversified range of small sections. In addition to the bar shapes generally used in the merchant trade, Gautier mills produce special sections used in making automobile springs, wheel rims, brake shoes, hinges, window sash, rail anchors, sled runners, etc.

Two central warehouses serve the Gautier merchant mills, and contain miscellaneous presses, cut-off machines and straightening machines for processing bar products.

ROD AND WIRE MILL

Wire rod is produced on a rod mill which was rebuilt into a three-strand unit in 1948. The mill uses billets 1¾ in. × 1¾ in. × 30 ft 6 in. which are heated in a single continuous furnace with a 25 ft × 32 ft hearth. The furnace is side charge, side discharge type, and is fired with coke or natural gas. Automatic controls are provided on gas-air ratio and furnace pressure. A toggle shear at the furnace exit cuts the heated billets in case of cobbles or to obtain samples of billets.

The rod mill is a 10-in. continuous mill, with 16 two-high stands in a straight line. The six roughing stands are separated from the ten finishing stands by a steam operated flying shear with electric trippers. The entire mill is driven by a 4000-hp, 375-rpm, 6600-volt induction motor. Roughing stands are driven through line

View of the nail department, which contains 110 machines for making various sizes of nails.

shaft and gearing, with belt drives to the finishing stands, to give speeds as follows:

Stand No.	Roll dimensions, in.	Distance from preceding stand	Roll, rpm	Speed, fpm
1	12⅛ x 15	....	23.4	71.79
2	11⅝ x 15	40 in.	36.6	104.62
3	12 1/16 x 15	40 in.	54.9	170.34
4	12⅛ x 15	45 in.	78.44	240.73
5	12 9/16 x 15	53.072 in.	104.87	342.60
6	12⅝ x 15	39 in.	139.86	449.88
7	9 3/16 x 15	16 ft 9½ in.	258.02	613.73
8	9 7/16 x 15	32.462 in.	334.74	890.70
9	9 23/32 x 15	36.862 in.	418.72	1061.20
10	9 25/32 x 15	32.822 in.	520.24	1316.30
11	10 5/64 x 15	32.83 in.	620.56	1635.83
12	10⅛ x 15	39.25 in.	739.01	1942.08
13	10 7/16 x 15	32 in.	840.48	2292.17
14	10½ x 15	33 in.	964.02	2632.0
15	10 13/16 x 15	30 in.	1058.23	2987.67
16	10 15/16 x 15	30 in.	1190.92	3378.42

All roll necks run in composition bearings, excepting No. 1 stand, which has babbitted bearings. All pinion bearings are babbitted. The main reduction gear set is equipped with roller bearings, while the gears at the mill stands are babbitted.

Rod leaving the mill passes through delivery pipes to four pouring reels that form coils up to 44 in. outside diameter and 317 lb in weight. Each reel is driven by a 35-hp, 400–1200 rpm, 230-volt d-c motor. Power is supplied to the reel motors by a 75-kw generator driven by the main mill drive motor. Coils are moved on to a pan-type conveyer which carries them to special trucks which take them to storage.

The mill produces sizes ranging 7/32, ¼, 9/32, 5/16, 11/32 and ⅜ in. in diameter, and No. 2, 3, 4 and 5 rod. The average rolling rate is 28.5 tons per hr, and power consumption runs 59.1 kwhr per ton for the main drive and 2.7 kwhr for the auxiliaries.

Complete facilities are provided for drawing and finishing, including three pickling units, one sulling tank, two batteries of flash bakers, four patenting units, two continuous galvanizing lines and 13 portable cover coil annealing furnaces.

A wide range of wire, from No. 36 gage up to 1 in. diameter, may be drawn in 24 single block machines, 11 double block machines and 47 continuous multiple block machines.

Wire may be further processed in 14 wire fence machines, 110 nail machines, three staple machines, 32 barb wire machines and four bale tie machines.

MISCELLANEOUS MANUFACTURING DEPARTMENTS

The Johnstown plant includes a number of manufacturing departments which produce many specialities not commonly found in steel plants.

At the wheel mill, steel rounds up to 15 in. in diameter and up to 15 ft long are cut into blanks on four cold saws or three slicing lathes.

No. 1 mill, which is used for small circular sections, is of the Slick design, wherein the heated blank, partially pierced to permit insertion of a mandrel, is forged by a combined rolling and pressing action between companion dies until the wheel takes the desired shape. The excess fin is then sheared off and the bore punched in a 170-ton hub press. This mill is driven by a 2000-hp, 2300-volt induction motor through a magnetic clutch. Blanks are heated for No. 1 mill in a circular type oil-fired furnace.

Wheels up to 45 in. in diameter may be produced in No. 2 mill. In this unit, blanks are heated in one continuous furnace and one batch furnace. There are also three reheating furnaces for intermediate heating. Two 12,000-ton presses do most of the shaping of the wheels, which then have the hubs punched in a 925-ton punch and are placed in a mill of Midvale design which rolls the tread, rim faces and web of the wheel. This mill is driven by a 900-hp, 230-volt d-c shunt motor. The wheels are then taken to a 2800-ton coning press, where the web is dished.

Pits are installed to provide controlled cooling of the forgings, and there are two circular hearth heat treating furnaces. The wheels are finished in approximately 50 turning, facing and boring mills.

This department also produces circular forged blanks used for gears, tire molds, turbine rotors, etc.

At Franklin works there is a complete car building shop, equipped to produce flat cars, gondolas, box cars, hopper cars, ore cars and mine cars by mass production methods on three assembly lines. Individual parts and sub-assemblies are fed into the main lines at the desired locations, and the finished cars, painted, stenciled and ready for delivery, roll off the ends of the lines. Steel car parts and components are also manufactured here. Car trucks are brought to the shop by special cars from a truck assembly shop at the Lower works. Cars are finished at the rate of one every 20 minutes on each of the two major lines.

The forge and axle department located at the Lower works, contains forging and machining facilities for production of forged railroad car and locomotive axles.

For standard car axles, 7, 7½ and 8⅛-in. diameter, round blooms are heated in a three-zone rotary hearth type furnace which is fired with coke gas and equipped with automatic controls. The blooms are forged on two 10,000-lb steam hammers which are equipped with

manipulators. The forged axles are then carried by chain drag conveyers to a straightener, then to cooling pits.

For locomotive axles and other special larger axles, square blooms are heated in a coke gas-fired batch type furnace and forged on a 15,000-lb manipulator-equipped steam hammer.

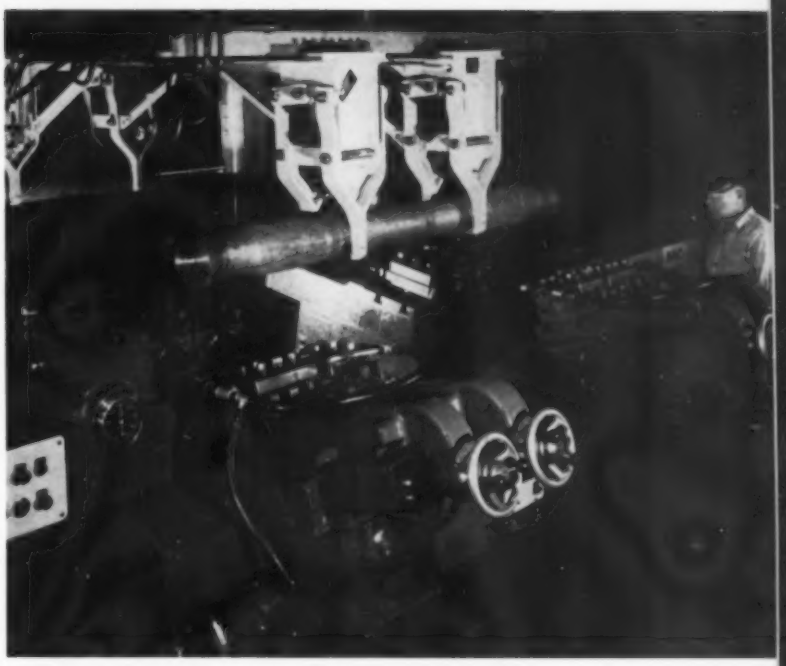
Forgings may be heat treated in two coke gas fired inclined hearth furnaces.

There are batteries of special equipped machines for cutting forgings to length, centering, rough turning parts of the axles or rough turning the entire axle; axles may also be finished on special grinders.

The axle and truck assembly shop finishes machining of axles and wheels, mounts wheels on axles, and assembles entire railroad car trucks for installation under cars being built in the car department at Franklin.

A mine car assembly shop is now under construction. Equipment for forging mine car wheels, machining of wheels and axles, also assembly facilities, are being transferred from the steel car department. This installation will free the wheel department of the forging of mine car wheels and allow time for other products in that department. It also will permit the steel car department to produce more welded freight cars.

The Gautier division contains a number of manufacturing shops which produce frogs, switches, switch stands, splice bars, rail joints, steel ties, rail anchors, guard rails, crossings, crossovers, turnouts and miscellaneous track accessories for light trackwork in industrial plants, quarries and mines. There are also a fence post shop, a wire product shop, and a building and highway specialty shop which fabricates bars, welded bar mats, dowel units, spacers and other accessories for use in reinforced concrete construction.



Axles for cars and locomotives are manufactured in the axle shop at Lower works, which contains complete facilities for forging and machining.

The structural fabricating shop, which is located at the down-river end of the Johnstown plant, provides complete facilities for fabricating, assembling and welding long span joists for building construction.

TABLE III

Boiler House Data

Station location	No. of boilers	Size of boilers, hp	Steam pressure, psi	Steam temperature, F	Total steam capacity, lb per hr	How fired	Steam usage
Lower works	6 2	300 525	135 135	550 550	85,000	Blast furnace, gas in pressure burners	
Lower works	2	3620	200 and 135	630 and 510	400,000	Blast furnace gas in pressure burners or powdered coal	Blast furnace blowers, power generation, mill drives, process and heating
Lower works	6	655	200 and 135	630 and 510	250,000	Coal on underfeed stokers	
Franklin	2	...	850, 250 and 165	850, 650 and 550	400,000	Blast furnace gas or fuel oil	
Franklin	3	...	400, 200 and 165	725, 625 and 550	400,000	Blast furnace gas or fuel oil	Blast furnace blowers, power generation, process, coke plant, open hearth, and wheel mill
Franklin	5	768	165	550	100,000	Coke breeze on chain grates	
Franklin	8	977	200 and 165	600 and 550	400,000	Coal on underfeed stokers and breeze on chain grate	
Franklin	8	500	165	550	120,000	Waste heat	
Rosedale	3	768	145	500	70,000	Coke breeze on chain grates	Coke plant
Rod and wire	2	525	125	500	30,000	Coal on stokers	Process and heating
Fabricating shop	3	90	100	338	9,000	Coal on stokers	Heating

SERVICES

Almost all of the electric power used in the plant is generated in four power houses, all operating on 25 cycles. At the Lower division is powerhouse No. 1, containing two 6000-kw, 2300-volt turbo generators operating on 200-psi steam.

Three powerhouses are located at Franklin division. In No. 2 station there are two 6000-kw, 2300-volt turbo generators operating on 150-psi steam. No. 3 station contains two 6600-volt units, one of 15,000 kw and one of 20,000 kw, both using 200-psi steam. This station is unique in that switching equipment is installed so as to split the three phases, each phase being on a separate floor of the building. At No. 4 station there are a 7500-kw, 6600-volt topping unit operating on 850-psi steam and a 20,000-kw, 6600-volt extraction turbine, also on 850 psi steam. Steam discharged from the two units is used to drive the turbo-blowers for K and L blast furnaces, and for general plant use.

All of the turbines except the topping unit are equipped with surface condensers. The condenser water from these units is re-used elsewhere in the plant, except that from the 20,000-kw unit at No. 3 station, which is equipped with a cooling tower for recirculating the water.

All four power houses are tied together by two 1,000,000-cir mil circuits operating at 6600 volts. A third 1,000,000-cir mil line provides an additional 6600-volt tie between No. 1 and No. 3 houses.

Power is distributed through the various parts of the plant and mining operations at 6600 and 2300 volts, requiring approximately 90 miles of transmission lines.

Forty substations located throughout the plant provide facilities for stepping 6600 and 2300-volt power down to 440 and 220-volt a-c power and for converting to 230-volt d-c power for auxiliaries. This requires 43 transformer banks, 26 rotary converters, 13 motor-generator sets and three rectifiers, of various ratings.

The peak hourly generation ranges 55,000–60,000 kw, while the daily production runs 1,000,000–1,300,000 kwhr, depending upon seasonal demands.

Because all power is generated in the plant, steam generation requires rather extensive facilities. There are 11 boiler houses, containing a total of 50 boilers, which provide an overall capacity for about 2,264,000 lb of steam per hr. Table III gives a summary of these stations.

Water for the plant comes from four reservoirs:

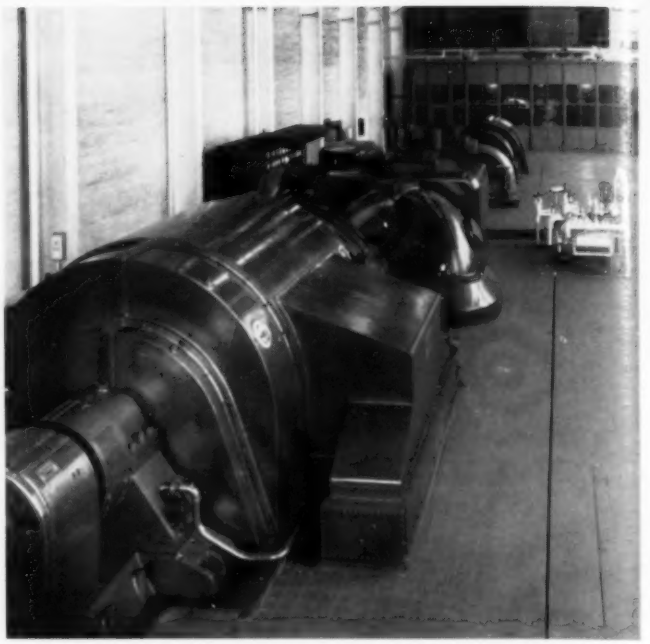
Quemahoning Reservoir, with a capacity of 11,490,000,000 gal, is connected to the plant by a 66-in. riveted steel pipe 14 miles long, and supplies about 81,500,000 gal per day.

Hinckston Run Reservoir, holding 1,128,000,000 gal, is tied in through a 24-in. cast iron pipe line 3½ miles long, and provides 5,700,000 gal per day.

From Border Dam on Stonycreek River, a 36-in. cast iron pipe line 7⅓ miles long carries about 18,500,000 gal a day.

South Fork Dam on Little Conemaugh River furnishes 23,000,000 gal a day through a 50-in. steel pipe line 1.4 miles in length, reduced to 48-in. reinforced concrete pipe 6.05 miles long.

The foregoing figures indicate a possible total water usage of 128,700,000 gal per day, not including what is recirculated in the plant.



All electric power is generated in the plant. No. 4 powerhouse, shown here, contains a 7500-kw topping unit and a 20,000-kw extraction unit.

At all of these reservoirs except that on Hinckston Run, the water is given a lime treatment to offset impurities due to coal mine drainage.

Water for boiler feed is taken from Hinckston Run and the domestic water supply. All feedwater is filtered and softened in zeolite softeners.

Major maintenance shops are located at the Lower works and include an iron foundry, brass foundry, pattern shop, blacksmith shop, machine shop, pipe shop, boiler shop, welding shop and electric shop. Some auxiliary maintenance shops are also located in the other divisions.

All observation, inspection, chemical and mechanical testing, and metallographic functions in the various divisions of the plant are supervised by the metallurgical department. Metallurgical supervisors in each division are in direct charge of quality and adherence to specifications in the case of any material processed in his division. Control laboratories are strategically placed throughout the plant.

Mechanical properties of the steel are checked in a main laboratory located in the Gautier division, which is the geographical center of the plant. Equipment in this laboratory includes one beam-type machine of 200,000-lb capacity and two new hydraulic dial-type machines, one of 60,000-lb and one of 300,000-lb capacity. A metallographic laboratory, also at Gautier, is equipped to test as-rolled hardness, hardenability, and impact properties. A supplementary laboratory designed specifically for testing of rod and wire products is located in the rod and wire division.

All sampling of raw materials and products is carried out at two locations in the plant. At Franklin works the chemical laboratories have recently been consolidated, bringing the facilities serving the coke plant and the iron and steel plants together under one roof. This unit is serviced by two pneumatic carrier tube systems, and results are reported by telautograph. Also, a modern direct-reading spectrometer has recently been installed.

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E. Pittsburgh, Pa.

. . . . adjustable voltage drives give smooth rapid acceleration and excellent maneuverability to ore bridge operation . . . .

▲ THE steel mill industry for the past several years has been involved in a general expansion program to increase and improve their production facilities. This program, at the Otis works of Jones & Laughlin Steel Corp., involved an increase in both the storage and unloading capacity of the ore yard. The ore yard, adjacent to the Cuyahoga River receives material by direct carrier shipment from the upper Great Lake region and stores several grades of iron ore and limestone. The yard is being lengthened to a distance of 1500 feet.

The ore unloading facilities available at the start of this expansion were two steam driven rope trolley unloaders with bucket capacity of 80 cubic feet. From these unloaders the material was stocked and reclaimed by an ore bridge of 15-ton capacity. This bridge has rendered service for forty years, but, like the unloaders, is unable to meet the material handling requirements of the expanded yard.

The program for solving this material handling problem calls for the installation of two modern ore bridges to serve in unloading, stocking, and reclaiming duty. One of these has been placed in service and is the immediate subject of this paper. When the second bridge is to be secured in the future, these two bridges will then completely replace the rope trolley unloaders and the original ore bridge.

The new bridge, erected in 1951, has a bucket capacity of 17 tons and a rated unloading capacity of 1040 net tons per hour, when unloading ore from a vessel to the middle of the stock pile. The bridge has a span of 377 ft and an over-all length of 573 ft. It offers the latest developments in ore bridge design and is the first in this country to be equipped with adjustable voltage drive. The electrical drive equipment is of great interest, particularly in the use of adjustable voltage and several operational and performance features.

The original ore bridge is operated from the 250-volt constant potential d-c supply rectified from purchased a-c power. With other phases of the expansion program requiring d-c power, the system does not have sufficient capacity to supply the new ore bridges. Alternating-current power at 4160 volts, 3 phase, 60 cycle was readily available and after long and careful study the decision was made to operate the bridge from this source.

Mill type d-c motors were the overwhelming choice for the individual drive, because of their rugged construction, low inertia, excellent performance and standardized construction. So basic was this decision

Figure 1 — The 17-ton ore bridge at Otis Works has an adjustable voltage drive.

that the specification might have been written "provide one ore bridge with maximum possible capacity using frame 618 d-c mill type motors for the hold, close and trolley drives."

Under the conditions thus established, an adjustable voltage drive offers the most favorable solution. Such a system was favored because of the following features:

1. It completely bridges the gap between the three-phase alternating current high voltage supply and the 230-volt d-c driving motors.
2. Secures the economies of high voltage alternating current distribution along the ore yard.
3. Permits the direct current motors to be operated at above rated voltage, therefore securing the desired capacity from motors within the standardized range.
4. Provides the performance features of smoother operation and better control of the bucket.
5. Secures equivalent accelerating rate with a reduction of the peak stresses on the mechanical parts and structural numbers.
6. Gives economical operation by virtue of practically eliminating acceleration losses.
7. Permits a trolley construction of lighter weight, which in turn is reflected throughout entire bridge structure.
8. Reduces the maintenance costs of the bridge.

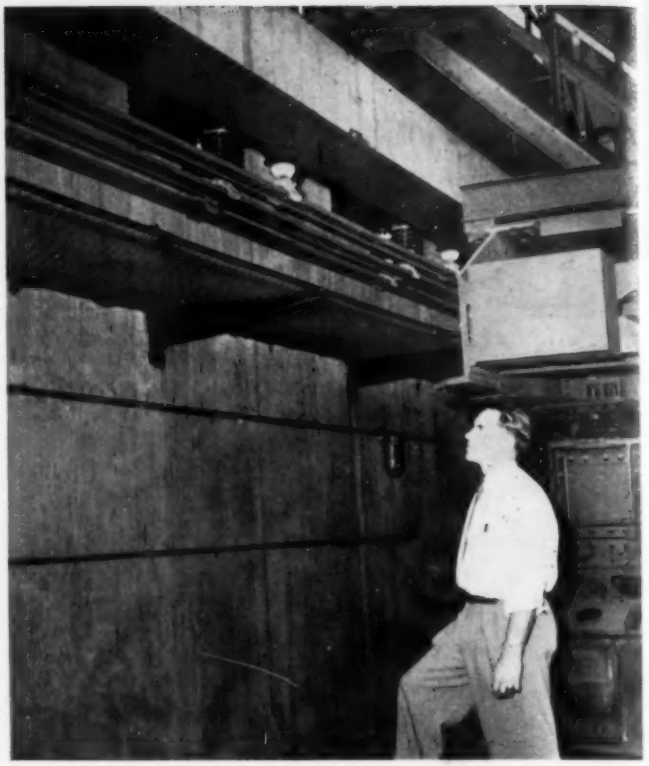


Figure 2 — The 4160-volt a-c collector system has a protective screen.

ELECTRICAL EQUIPMENT

The alternating-current power is picked up by a 3-phase double shoe type pick-up located at the base of the pier leg. The collector rails, mounted on the base of the trestle, are located ten feet above ground. A metal screen provides further protection against accidental contact by personnel. A main disconnect switch of the load break type is located at the base of the pier leg in the travel control house. From it the power is carried up to the main machinery house located on top of the bridge over the pier leg. Here the main motor-generator set is located.

Starting equipment for the synchronous motor is of the drawout air circuit breaker type providing full voltage starting.

The main motor-generator set is driven by a 1500-hp, 80 per cent power factor, synchronous motor operated at 900 rpm and having a pull out torque of 225 per cent full load torque. Individual d-c generators are provided for the hold and close drives, two generators for the trolley drive and a single generator for the constant potential d-c requirements. All the generators have duplicate frames and armatures and those for the adjustable voltage drives have duplicate fields as well. The motors and generators are mounted on a rigid self-supporting bedplate which is supported at three points by the ore bridge structure. This method of support was chosen to prevent the bedplate from becoming an integral member of the bridge structure with resulting stresses and flexures.

The adjustable voltage generators are rated 200 kilowatts at 275 volts. These ratings are nominal as the machines have been designed for the specific duty anticipated on this ore bridge. For instance, the hold and close generators operate at 305 volts to drive the motors at 530 rpm. At this speed, the motor output is 315 hp one hour at the rated 75C rise. Similarly the trolley generators are operated at 398 volts obtaining output from each of the trolley motors of 415 one hour hp at 700 rpm. By thus using the shunt wound 230-volt mill motors at above nominal voltage, considerable weight is saved over the use of larger 230-volt motors in a constant potential drive. At the same time, savings in the inertia of rotating parts are also effected.

Speed and torque regulation of the adjustable voltage drives are secured by the use of rotating regulators mounted on the trolley. For convenience in mounting, the regulators are assembled in two motor-generator sets. These are driven by 3-phase squirrel cage induction motors. A d-c generator is also mounted on one set to supply constant potential d-c for the brakes, the motor fields and control energy.

The master switches, located in the operator's cab, control the pattern field of the rotating regulators directly without interposing relays, and in turn the output of the main rotating regulators is transmitted through the collector system to the field of the respective generators for the hold, close and trolley. Other possible arrangements for this equipment could have been made mounting the rotating regulator units in the main machinery house and transmitting the signal from the master switches to the rotating control pattern field over the collector system. However, the location of the rotating control units on the trolley was preferred by the J. & L. engineers.

The current limit rotating regulator units take their intelligence from the current in each loop and the desired division of lead. Their output is made effective through the current limit field on the main rotating regulators for each drive.

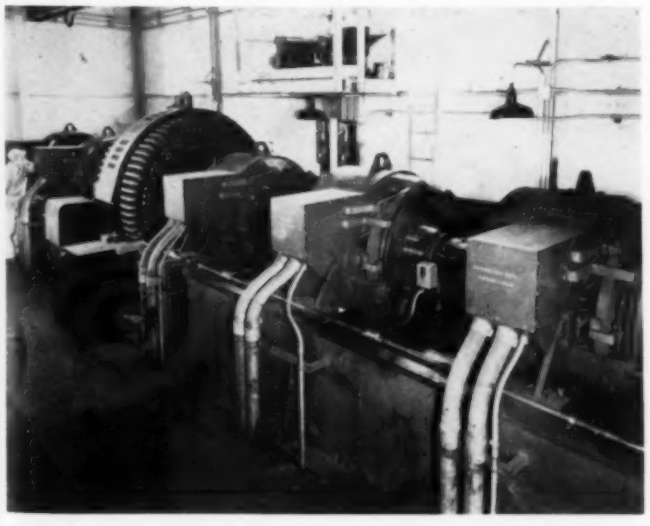
A further requirement of this ore bridge was that the

master switch arrangement and operation be similar to that of the present existing ore bridge. This meant that the hold and the close master switches had to be located on opposite sides of the operator with the trolley control master switch further to the left side. This arrangement made it difficult to correlate the relative positions of the hold and close master switches for bucket control and brought about the development of a novel control system. In this system one master switch controls the vertical position of the bucket causing both the hold and close motors to operate simultaneously and at the same speed. The second master switch controls only the operation of the close motor. Simultaneous operation of both master switches superimposes the indication of the close master switch over and above the speed indication of the master switch which controls the bucket vertical position.

To further permit complete control of the bucket in stocking and reclaiming operations, a load regulating system was built into the control requiring the hold and close motors to share the load equally when the bucket is loaded and requiring that the weight of an empty bucket be carried entirely by the hold motor. The factor which determines which of these two load sharing relationships is effective is the most recent direction of motion of the close drive before the hoist master switch is used. If the close drive was operated in a direction to close the bucket, it is assumed that the bucket contains load and the equal load sharing is put into effect. Should the last previous operation of the close master switch have been in the open direction, then it is assumed the bucket should remain open and the system operates automatically as the hold drive takes the full share of the load and operates the close drive at the same speed but under negligible load.

This load regulating system performs exceptionally well, permitting the bucket to be raised or lowered either empty or full without any tendency for the bucket to close or open. It further permits the bucket to be closed or open while being raised or lowered and also permits very fine control of the bucket when delete digging on the side of a pile under which condition the bucket tends to fall over if not supported by the suspending ropes.

Figure 3 — Main motor-generator set is located in machinery house.



Overtravel of the bucket in the hoist direction is prevented by two shunt type limit switches mounted on the trolley. When either of these switches is tripped by the bucket, both hold and close drives are stopped.

Trolley travel protection is provided by track type limit switches which enforce two speed check points at each end of travel. Should the trolley be moving in excess of the prescribed speed when it passes either of these check points it is automatically slowed down.

To permit the maximum flexibility in bridge operation, a switch is provided in the operator's station to cut out the hold or close line, readjust the control circuits and permit operation on one motor only. A similar selector switch also permits the operator from his cab to cut out either of the two trolley motors.

An emergency stop button at the operator's station permits him to remove power from all driving motors, establish dynamic braking circuits and set the brakes. Loss of a-c power causes an a-c low voltage relay to trip on the trolley. Loss of synchronous motor field, motor-generator set overspeed or synchronous motor overload will trip the constant potential d-c circuit breaker feeding the trolley. This in turn causes the d-c low voltage relay on the trolley to function the same as pressing the emergency stop button. The driving motors are supplied with field loss relays which operate in a similar manner.

The two pole breakers in each power loop circuit provide protection against accidental grounds or short circuits in the power collectors. Double brushes are used on all circuits. Opening any of the main adjustable voltage power loop breakers also trips the d-c constant potential breaker feeding the trolley which shuts down all of the drives as indicated above. Interruption of any of the collector circuits with the exception of the adjustable voltage power loops will either immediately stop all drives on the trolley and set the brakes or will cause the drives to operate at creeping speed. Interruption of the power loop collector will cause the drive to drift free whereupon the operator can either set the brakes by centering his master switch or further establish dynamic braking by "hitting" the emergency stop button.

ACCESSORY DRIVES

The bridge travel, apron hoist, turntable and lifting magnet are all supplied from the 200-kilowatt, 250-volt constant potential d-c generator mounted on the main motor-generator set in the machinery house on top of the structure. This generator also supplies the synchronous motor field and the control circuits in the main machinery house. The output of this generator passes through a main circuit breaker and a ground protective panel is provided for the circuit feeding the bridge travel, rail clamp and apron hoist drive.

Each end of the bridge is propelled by two 100-hp, frame 612 series wound mill motors connected in series across the 250-volt supply. With this arrangement the motors operate at essentially half voltage and half speed while providing the full rated torque. Individual shunt wound brakes are supplied for each motor.

The bridge control is of the full magnetic reversing-plugging type with the master switches located in the

Figure 4 — Operator's cab shows arrangement of master switches.

operator's cab. Individual master switches are provided for each end of the bridge. The control panels for each end are located in a house on the respective leg just above the sill. Polarity and potential sensitive relays are used to permit three-speed reversing control to be supplied from each master switch with two collectors for each end. The usual anemometer protection against operation in excessive wind is provided. Also skew protection provides one slow-down point and automatic stopping if excessive skew should develop. Normal skew control is obtained from shunt type limit switches operating in the control circuit. Back-up protection for excessive skew is obtained by power type skew type limit switches arranged to remove the power from the driving motors.

Rail clamp controllers are included with the bridge travel control for each end and operate to raise the clamps when a foot button in the operator's cab is depressed. Release of the foot button, operation of the anemometer or power failure cause the rail clamps to be automatically set under control of dynamic braking.

The apron hoist is driven by a 75-hp frame 612 series type mill motor with full magnetic dynamic braking lowering control. This drive with its control equipment and master switch are located in a separate apron hoist house located in the upper portion of the structure at the shear end.

In order to facilitate clean-up operations, the trolley is equipped with a turntable which permits the bucket to be rotated 90 degrees. This turntable is driven by a frame 602 mill motor with reversing-plugging control. The turntable motion is controlled from the master switch located in the operator's cab.

A 112½ kva, 4160 volt to 480 volt, 3-phase dry type power center supplies low voltage alternating-current

Figure 5 — Rotating regulator set and instrument panel are located on trolley. At the left is controller for turntable.

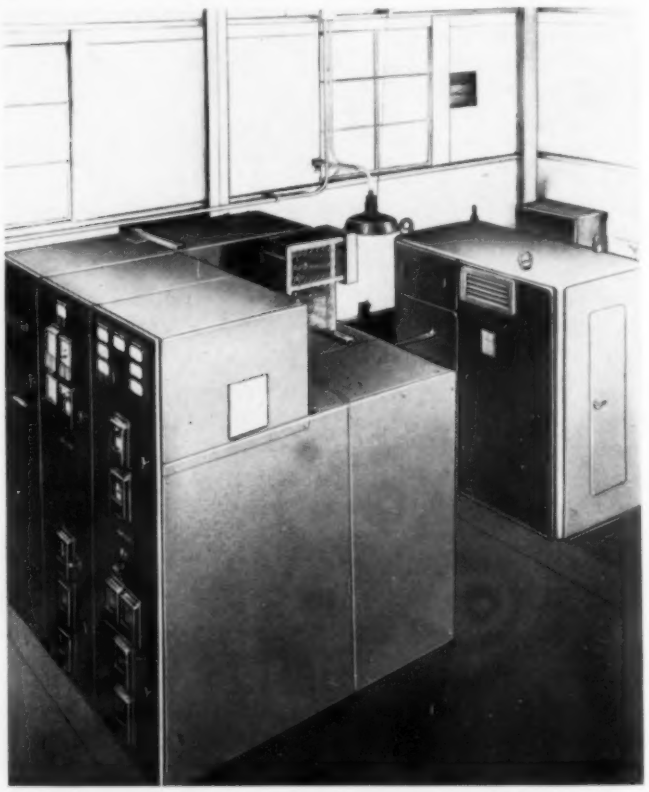


Figure 6 — The 112½-kva power center in machinery house supplies 440-volt a-c auxiliary drives, light and heat.

power for auxiliary drives. This power center is complete with a high voltage load break disconnect switch and high voltage current limiting fuses. On the low voltage side two air type circuit breakers are provided. One feeds those circuits on the trolley and the other feeds those circuits on the bridge structure itself.

On the bridge structure those auxiliaries driven by alternating-current include the ventilating equipment in the main machinery house, the repair hoist in the main machinery house, lights on the bridge structure and legs, repair hoists in the apron hoist house, the trolley repair crane and the bucket buggy. On the trolley alternating-current is used for light, heat, ventilation of the trolley control room and for driving the rotating regulator motor-generator set.

PERFORMANCE

The ultimate test of any piece of material handling

equipment is — how well does it work? This bridge was erected in 1951 and used during the fall of that year in miscellaneous duty including yard clean up, stocking ore received by rail and in reclaiming work. In unloading from gondola cars, the excellent control of the bucket proved of great advantage. The cars were cleaned very well with the 17-ton bucket and required very little hand work.

Extensive tests were taken on the bridge in February 1952 which showed the bridge capable of meeting all initial requirements. Table I presents the significant data.

TABLE I

Performance Data

	Guaranteed	Secured
Hoist speed	260 fpm	280 fpm
Lower speed	286 fpm	314 fpm
Trolley speed	1200 fpm	1290 fpm
Average trolley acceleration rate	3.0 fps^2	3.0 fps^2
Cycle time	58.6	57.0
Unloading capacity	1040 tons/hr	1070 tons/hr

The tests, taken in February, did not permit unloading from a ship but conditions were simulated to permit creating a typical cycle. Of particular interest in these

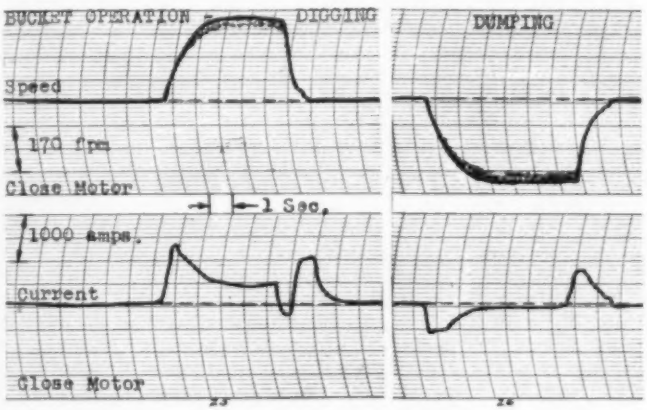
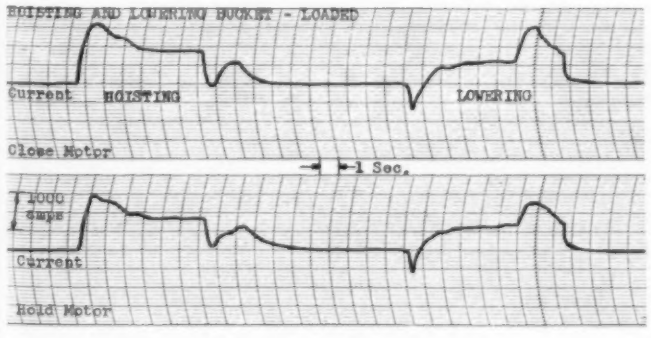


Figure 7 — Current and speed characteristics of bucket drive during digging and dumping operations.

tests are certain of the charts taken by Brush type oscillograph. Figure 7 presents the current and speed of the close motor during digging and dumping operations. These should prove of particular interest to machinery builders and electrical manufacturers who

Figure 8 — Hold-and-close motor currents with loaded bucket are shown by charts.



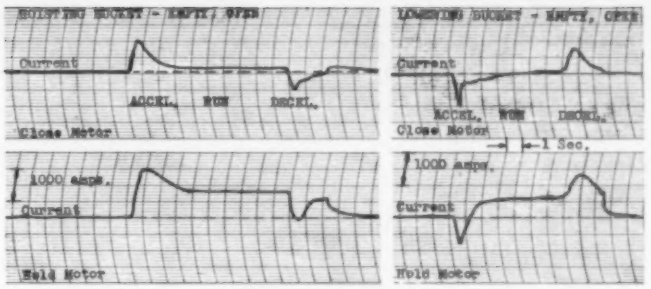


Figure 9 — Hold-and-close motor currents with empty bucket are shown by charts.

are continually asking for bucket performance data. The bucket used was a 17 ton capacity Wellman bucket which weighed approximately 34,000 lbs.

Figure 8 represents the comparative currents in the hold and close drives when hoisting and lowering a loaded bucket. For this operation the regulating system should and does equally divide the load between the two motors.

The chart presented in Figure 9 illustrates the current in the hold and close motors while hoisting and lowering an open bucket. The effectiveness of the load regulating

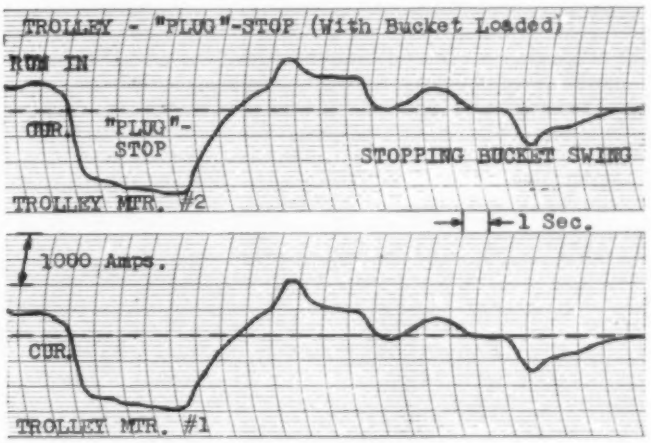
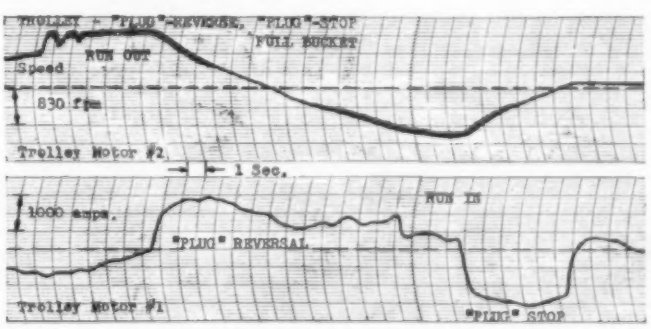


Figure 10 — Current in trolley motors during "plug" stop is about equal in both motors.

system in transferring the load to the hold motor is clearly demonstrated.

The use of two shunt wound motors in parallel in the adjustable voltage trolley drive presents the problem of assuring equal load distribution. This has been obtained by the use of a load-sharing rotating regulator (the two-circuit rotating control unit is used for both trolley load sharing and current limit). This regulates

Figure 11 — Speed and current of trolley during reversal and "plug" stop.



the field strength of the motors to maintain equal current. This method was preferred over the use of large blocks of power wasting resistors in series with each motor to permit inherent load sharing. The effectiveness of this regulation is illustrated in Figure 10 which represents the current of the trolley motors during a "plug to stop" operation with empty bucket.

The smooth performance of the adjustable voltage control is well illustrated in the constant slope of the speed vs time curve for the trolley with full bucket during reversal of direction as shown in Figure 11. All acceleration and reversal operations were performed with the master switch thrown from the off to its full speed operating point.

The adjustable voltage drive characteristics of smooth rapid acceleration and excellent maneuverability together with the excellent overall design of the entire bridge, produce an ore bridge which is meeting every production requirement made of it.

DISCUSSION

PRESENTED BY

E. L. BLANKENBEKER, Electrical Engineer, Heyl & Patterson, Inc., Pittsburgh, Pa.

F. SANTIAGO, Electrical Engineer, Wellman Engineering Co., Cleveland, Ohio.

R. A. HESS, Senior Electrical Engineer, Armco Steel Corp., Middletown, Ohio.

S. RIFKIN, Application Engineer, Industrial Engineering Div., General Electric Co., Schenectady, N. Y.

W. TADDEO, Master Mechanic in Charge of Electrical and Mechanical Maintenance of Blast Furnaces, Bethlehem Steel Co., Bethlehem, Pa.

CLARK B. RISLER, Industry Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

E. C. JUHNKE, Electrical Engineer, Jones & Laughlin Steel Corp., Otis Works, Cleveland, Ohio.

E. L. Blankenbeker: The company with which I am associated has been promoting this type of bridge drive, where applicable, for several years, and took part in the preliminary planning of this bridge. We have two similar bridges in operation in Canada and are presently building a high capacity man trolley unloader of such type on the eastern seaboard.

The features described in this paper favoring the use of adjustable voltage over constant voltage have been proved in service for new dock or yard installations or where increased handling capacity is required on existing docks. The increase in inquiries and purchases of this type of drive over the past few years is definite proof that adjustable voltage equipment is being favorably received by the users of heavy bulk material handling equipment. Each job is somewhat different due to local conditions or to individual preferences. It is to be expected that as more experience is gained, the manner of handling the many component problems will become more standardized.

Since the paper did not include an elementary single line diagram to show details of the control scheme, this discussion will be confined to general comments.

The number of trolley runway contact conductors with their current rating was not given. On the two similar bridges in Canada previously mentioned, we applied four power circuits and eight control circuit contact conductors to the trolley runway for a total of twelve. This compares with the eight circuits that are normally required on a constant voltage trolley runway.

It is noted that the hoist motors were applied to operate at only 26 per cent overspeed by overvoltage. We would like to ask if frame 616 motors at about 70 per cent overspeed, overvoltage operation were considered for the hoist drives for the purpose of reducing trolley weight.

We agree that the proper place for the adjustable voltage control including the rotating regulator equipment is on the trolley so as to be within speaking distance from the master switches for maintenance reasons.

The paper stated that the purchaser stipulated that master switch arrangement be similar to an existing bridge that was 40 years old. This type of stipulation handicaps the designer in making modern improvements. Figure 4 which shows the interior of the cab shows at least six master switch handles, spaced considerable distances apart, all of which seem to be used frequently. It would appear to require considerable stretch from the bucket masters to the bridge masters mounted upside down. It is possible to obtain control of all motions with only three master switches and two foot operated switches without the operator having to remove his hands from the handles used most frequently. The programming scheme for the two bucket masters appears to be very desirable in this case where they both cannot be operated by the same hand. This same bridge operator that insists on switch arrangements similar to the 40 year old job would be unlikely to specify a model "T" pedal lay-out in his new 1953 model fluid drive automobile.

I would like to ask the authors to describe more fully the operation obtained by the bucket when only one hoist motor is available and with the controls readjusted? Also does the emergency stop button in the operators cab provide for stopping the bridge drive motors and setting of the rail clamps?

ACCESSORY DRIVES

The so-called accessory drives have been clearly described. This scheme requires a constant voltage generator of considerable size. Some alternative schemes will be briefly described. Very little, if any, time is lost if bridging and hoisting are not done simultaneously and this would permit using the bucket hoist generators to drive the two ends of the bridge legs by adjustable voltage. This type of drive offers advantages in smoother

starting and stopping and permits operation of both the bucket and the bridge legs from the same master switches. A corrective skew control for the bridge drive using adjustable voltage can be applied to the generator fields to provide multi-point correction by means of field rheostats operating as skew switches.

The apron hoist could be powered by an a-c hoist type motor and control which would permit movement of the apron at times when the motor-generator set was not running or not available for running.

PERFORMANCE AND TESTS

The builder, equipment supplier, and owner of the bridge are to be congratulated on the excellent performance record of this bridge. The oscillograph tests appear to be the most complete data that has been published in modern times. It is hoped that this type of testing can be carried out on more new jobs as they are erected. As a rule the owner is so anxious to put the bridge into productive operation that time cannot be allowed for making tests.

Calculations based on Figure 7 indicates about 26 feet of rope taken-in to close the bucket in 6.3 seconds and 30 feet of rope paid-out to open the bucket in 8 seconds. Perhaps the authors can comment on this difference in amount of rope taken-in and paid-out. Also 6.3 seconds is faster closing time for a 17-ton ore bucket than we normally consider possible for digging a full load in compacted ore.

Figure 10 indicates a total plugging current for the trolley drive of about 3000 amperes for approximately four seconds. I would like to inquire if these severe current peaks produce any ill effects on the trolley circuit collector shoes.

F. Santiago: There is a correction, or rather an explanation that should be made about the capacity of the bridge. You may note that a figure of 1040 tons per hour is mentioned. It should be pointed out that this figure is theoretical, based on free digging at 100 per cent operator efficiency. From our experience it seems that 65 per cent of this figure would give a good average capacity of the bridge, including normal clean up. This is a point apt to be misunderstood by some engineers outside of the steel industry, and should always be explained in the specifications.

I witnessed the test runs in February of this year, and I was not so impressed by the high performance of the bridge as I was by the reluctance of the operator to run the trolley at full speed. He may, by now, be used to it; however at the time of the test an engineer had to put both his hands on the trolley master switch to be able to get a complete test without interruption from the operator trying to slow it down. It would be interesting to know how this situation stands now, since it would be a waste of money and material to have all this potential power available and not use it.

I suppose the authors will have some comment about Mr. Blankenbeker's statement and questions, but I would like to point out that the types of drives used on this bridge were specifically requested by the owner. I do agree with his statements on the up-to-date system using the hold and close motion generators for bridging, and we have figured some projects on that basis.

Regarding the collector rails, it is true that it can be done with about half the rails available, but for insurance of continuity, the owner wanted the number of rails that we have used. In future installations it does not necessarily mean that we have to use 21 rails, like we have at the J & L bridge.

R. A. Hess: We are erecting at the present time, an ore bridge at our No. 3 blast furnace that is similar to the one just discussed. Our bridge is designed to handle a 15-gross ton bucket and have a capacity of 1120 gross tons per hour.

We are using Frame MCPA-616 motors, rated 187.5 hp, one hour, for the hold, close and trolley drive. We are going to operate these motors at a maximum voltage of 365 volts with a corresponding increase in hp and speed.

Our bridge will be supplied by a 4160-volt, 3-phase source star connected with grounded neutral. The main motor-generator set consists of four 200-kw adjustable voltage generators and one 40-kw constant potential generator driven by a 900-hp, 1200-rpm synchronous motor.

Two 200-kw generators supply the trolley drive motors, one 200-kw generator supplies the hold line motor, and one 200-kw generator supplies the close line. The bridge motors are supplied from the hold and close line generators. The power and control is supplied from the machinery house to the man trolley over 13 collector rails, 8 power rails and 5 control rails.

One distinct difference between our bridge and the Otis works bridge is the location of the rotating controls. We are putting all ours, except the trolley motor load balance rotating controls, in the bridge machinery house.

There are several questions I would like to ask:

1. What was the reason for putting all the rotating regulators in the man trolley control house?
2. How many man trolley collector rails do you have and are they inverted angles?
3. What kind of construction did you use for the 4160-volt collector rails? Do you feed one end of the collector rails only or do you run a high voltage cable parallel to the collector rails and tap the cable to the collector rails at various points?

S. Rifkin: As evidenced by this extremely interesting and excellently illustrated paper, adjustable-voltage ore bridges are not simply an engineering dream; although, if I may be poetic for a moment, I might say that their performance is really a "dream." The automatic features that match holding and closing line speeds, especially during acceleration and deceleration, the reduced total accelerating and decelerating time for the trolley, the smooth operation with less operator fatigue, the reduced power consumption and reduced maintenance expense are features that make it advisable to investigate the possibility of utilizing adjustable-voltage whenever a new installation or a major revamp of an existing installation is being considered for unloading or stocking ore and coal.

As I have mentioned at previous AISE meetings, the adjustable-voltage system for bulk materials handling is not new. A New York utility has at least four adjustable-voltage coal unloaders, the first of which was installed in 1924. When they purchased a new unloader recently, the specifications definitely required that an

adjustable-voltage system be provided. A rope-operated ore bridge has been in service in Chile since 1927. Of course, those early installations had simple adjustable-voltage systems without any type of rotating regulators. However, in 1943, a rotating regulator controlled rope-operated unloader was installed by the Semet-Solvay Corp. near Buffalo, N. Y.

Nevertheless, it has been only during the past few years that a comparison of total installed cost and an evaluation of reduced operating expense has led to a more widespread consideration of adjustable-voltage. In order to illustrate a few of the many possible alternate arrangements that differ from the Otis works bridge, I would like to call your attention to a few of the features provided in the rotating regulator controlled bridge at the Dominion Foundries & Steel Co.,

Figure 12 — One of two 12-ton ore bridges for Dominion Foundries and Steel Co., Ltd. in Hamilton, Ontario, Canada is shown lowering open bucket into ore boat.

Hamilton, Ontario, which has been in regular service since the summer of 1951. This 12-ton bridge has a free digging unloading capacity of 935 tons per hour. The hold, close, and the two trolley travel motors are MDP 418's, since the AISE "600" frames were not yet being manufactured in Canada at the time the bridge was purchased. The hold and close generators are rated 150 kw, 350 volts; the single generator supplying both trolley motors in parallel is rated 400 kw, 425 volts, and the flat compound wound generator supplying the apron hoist, the rail clamps, the motor fields, the brakes, and the control circuits is rated 40 kw, 250 volts. The driving motor of the motor-generator set is selected on a duty cycle basis, and is only a 600-hp, 70-per cent power factor, 1200-rpm synchronous motor with a pull out torque of 275 per cent.

Figure 12 shows the bridge as an empty bucket is being lowered during an unloading operation. The control cab and operator's cab on the trolley are relatively small. There are only three master switches in the operator's cab, and yet the operator has control over the hold, close, trolley, pier leg, and shear leg drives. This may sound contradictory, but the explanation is quite simple. Because the hatch openings on lake carriers are quite wide, there is no necessity for "throwing" the bucket under a hatch combing. Consequently, the bucket and the bridge travel motions need not be operated at the same time. By simply stepping on a foot switch, the operator transfers the hold and close line generators along with part of the control to the six 19-hp motors on each leg. The pier and shear legs can then be operated either independently or simultaneously by means of the hold and close line master switches.

When the closed bucket is being raised with both master switches in the full speed position, the rotating regulator circuits automatically divide the load between the holding and closing lines. In the lowering direction, the speeds of the holding and closing lines are automatically matched as long as both master switches are in the same position; thereby maintaining the opened or closed relationship of the bucket jaws even during acceleration and deceleration. If a loaded bucket is being lowered with both master switches in the full speed position, the speed matching circuit is changed to the load dividing circuit at the end of the acceleration period; thereby dividing the load between the holding and closing lines. If the operator wishes to open or close the bucket while it is in motion, he simply moves one master switch ahead of the other. These features are provided without any action on the part of the operator, and they do not require any "memory" devices or selector switches.

In addition to voltage and current-limit control, the trolley rotating regulator provides an essentially constant rate of acceleration and deceleration throughout the speed range.

Figure 13 is a simplified diagram of the major circuits. It shows that even with three collectors to bring a-c power onto the trolley for lights, heaters, the turntable, and the rotating control set, the use of the common return collector results in a total of only twelve collectors between the trolley and the bridge structure. Note also that the hoisting currents in the hold and close line motors flow in opposite directions; thereby reducing the total capacity required in the common return collector.

A duplicate bridge has been installed at the same location, and another bridge with similar electrical features has been placed in service at the Steel Co. of Canada, in Hamilton, Ontario.

Man trolley type ore unloaders with rotating regulator control are being built for the Western Maryland R. R. Co. in Baltimore, for the Canton R. R. Co. in Baltimore, and for Tennessee Coal Iron & R. R. Co. in Mobile. The Canton R. R. and the TCI unloaders will have 20-ton buckets and a free-digging capacity of 1850-1900 tons per hour. One unloader has a sixth generator on the motor-generator set to provide adjustable-voltage tower travel operation, and another unloader has a constant-potential d-c tower travel drive. Both systems permit simultaneous operation of the hold, close, trolley and bridge motions. These are only a few examples of the optional features that can be obtained with an adjustable-voltage drive. It can certainly be said that adjustable-voltage is being used to move more and more mountains of material.

W. Taddeo: There is no doubt in my mind concerning the advantages of the adjustable-voltage control for ore handling facilities as described in the excellent paper just presented. In fact, it appears to me that we now have the solution to all the problems of the constant-potential system commonly used.

However, while all the advantages were clearly emphasized, there are still some features, from a practical

standpoint that are questionable. The following remarks are based on my experience with constant-potential rheostatic control on three ore bridges and variable-voltage control on five blast furnace skip hoists at the Bethlehem plant of Bethlehem Steel Co.

First of all, the high-voltage collector system, while it does completely bridge the gap between the three-phase alternating-current high voltage supply and the 230-volt d-c driving motors and also secures the economies of high voltage alternating-current distribution, increases the hazards associated with any collector system. It is doubtful that the Bethlehem plant with its enviable safety performance would consider such an installation if there was the remotest chance that its safety record would be impaired. Also I am trying to imagine how successfully a high-voltage collector system can operate in the dust laden atmosphere prevalent in all ore yards.

Again, speaking of collector systems, it appears to me that the adjustable-voltage control complicates it rather than simplifies it. Ordinarily, this would not be important as recent developments have made these systems very reliable. But the control, as described, obviously increases the number of collector rails and at the same time introduces sliding contacts in the main power circuits between the generators in the machinery house and the hoist and trolley motors on the man-trolley. It was admitted that any interruption of the power loop circuit will cause the drive to drift free. This feature definitely is not desirable because a run-away could occur if the operator, for some reason, did not center his master switch or push the emergency stop button. In the excitement some operators "freeze"; others forget the emergency measures. In either case, a serious accident will result.

But assuming the operator to be alert and doing what he is supposed to do, no explanation has been presented as to how emergency dynamic braking is accomplished. Does this feature include the use of large contactors and heavy resistors across the main motors? If it does, then the control does not eliminate the use of large power contactors but rather it does reduce the number of these contactors to the bare minimum. The advantage, of course, is in the very infrequent operation.

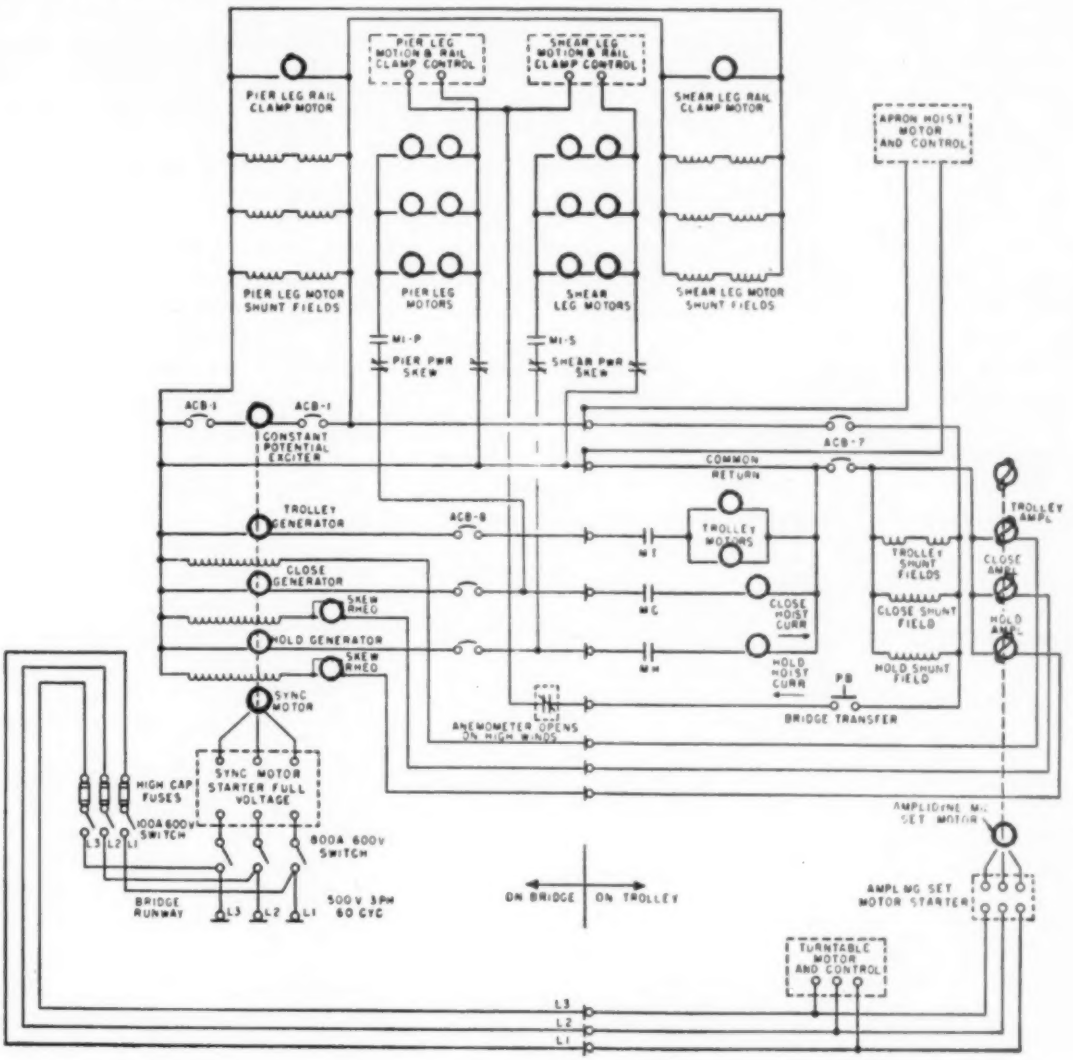


Figure 13—Schematic diagram of ore bridge control.

Are these same contactors controlled in any way by a circulating-current sensitive relay? If not, how do you prevent circulating currents that are generated by residual magnetism in the main generators? In the variable-voltage controls of the blast furnace skip hoist there is incorporated a suicide circuit which passes the circulating current generated through the main field coils and excites them differentially with respect to the residual field.

It was not mentioned whether or not the bridge travel drives are 100 per cent anti-friction. In most cases the axles are equipped with babbitted bearings deliberately

to supply some friction or resistance to travel, especially when there is a strong wind. For this reason also, constant-speed shunt motors are preferred. What is the explanation for the choice of series motors for this operation?

Being familiar with the operation and maintenance of ore bridges, I would list the following as the greatest advantages of the adjustable-voltage control:

1. Better bucket control.
2. Smoother acceleration.
3. Less trolley weight.
4. Lower operating costs.
5. Lower maintenance costs.

Taking everything into consideration I think that the adjustable-voltage control is far superior to the constant-potential rheostatic control. Even the higher first cost is eventually absorbed by the lower operating and maintenance costs. It is rather unfortunate that the industry in general has been quite reluctant to accept it.

Clark B. Risler: The number of collectors on this ore bridge is one of the numerous questions which has been raised. There are twenty-one collectors used to provide individual collectors for each main drive power loop, two individual collectors for each control circuit (that is for each drive under adjustable voltage control), three for the control of bridge travel from the trolley, one for rail clamp control, and three to provide three-phase alternating current on the trolley. As indicated by Messrs. Hess and Rifkin, a considerable reduction in the number of collectors can be made by combining functions. In this instance, the ultimate user requested that the independent identity of all drive functions be retained and this requires the larger number of collectors.

Mr. Blankenbeker inquired if the frame 616 motor has been considered for some of the drive motions on this bridge. It has been a long time since the preliminary negotiations were in progress, but my recollection is that at the ultimate customer's request, frame 618 motors were considered from the beginning for the hold, close and trolley drives.

The location of the rotating amplifier equipment has been discussed. They can be located either on the trolley or in the machinery house. One of the great advantages of adjustable voltage control is a very marked reduction in the weight of the electrical equipment on the trolley which is highly desirable as it reduces the large mass which must be accelerated and retarded every time you go through a duty cycle. Furthermore, the rotating control units are supplying the fields of the main generators which are located in the main machinery house. We, therefore, favor the location of these controls in the main machinery house.

A question has been raised about the emergency operation of the bucket with only one motor. Under such conditions, the motor would be operating at above its rated current, particularly if the bucket were loaded, and the entire bucket was being raised on the close line. Some adjustment of the current limit setting had to be made at the time of the transfer in order to permit such operation. This did bring about a moderate amount of additional complication in the control, but it was felt that the desire of getting out of a tight spot in a hurry without having to call in additional assistance warranted the adjustments which were made on the control for this particular ore bridge.

As the control is now arranged, the emergency stop pushbutton in the operator's cab applies only to those drives on the trolley itself. The operator by either centering the master switch or by releasing the rail clamp pushbutton can stop the bridge travel drive.

The merits of adjustable voltage drive for the bridge travel motion have been very well expressed. In this instance, however, the requirement of simultaneous operation of the bridge travel and bucket hoisting and trolley motions precluded the possibility of using adjustable voltage for bridge travel without adding a separate generator exclusively for this purpose.

Mr. Blankenbeker has commented upon the digging characteristics obtained during the tests performed on this bridge and inquired further about them. The bucket was lowered on top of the ore storage pile and the digging performance, recorded in the illustrating figure was taken from a standing start with the bucket open and resting on top of the pile. A rated tonnage of ore was secured in the bucket on the digging cycles during the test. He further commented on the differential of rope during closing and opening of the bucket. This can be accounted for in part at least by the fact that the head of the bucket frame remained stationary during opening whereas during digging the head of the frame is lowered into the pile.

In regard to the collector rails, the rails on the bridge are steel angles and backed by copper. Also the peak currents associated with acceleration of the trolley drive have had no particularly detrimental effect on the collector system. As to the location of the power feed to the conductors running longitudinally along the ore pile, I do not know where the power was placed into the collector system. That was done by the J & L organization. Mr. Juhnke do you recall where the power leads were brought in or was power applied at several locations?

E. C. Juhnke: One location in the center.

Clark B. Risler: The question of safety has been raised in connection with the high voltage collector system along the ore yard. I believe it can be said without question that every consideration has been given to safety in laying out this collector system and that it has given no difficulty in this regard.

Mr. Taddeo inquired about the dynamic braking resistors and contactors. To secure the emergency dynamic braking features, we have to have a spring closed contactor which establishes a circuit around the motor and places a dynamic braking resistor in this circuit. This has to be a large contactor but it does not operate on a duty cycle basis, but rather only when the drive is shut down or when an emergency occurs. Hence, such contactors do not require a large amount of maintenance attention in comparison to contactors in a constant potential system which are in operation once or twice every duty cycle.

In conclusion I should like to express my appreciation for the excellent discussion presented this afternoon. The broad scope has permitted a quite thorough review of the subject of adjustable voltage drives for ore bridges.

PROTECTION OF UNDERGROUND CABLE SHEATHS

By T. W. ALEXANDER, JR.
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. . . . a knowledge of stray ground currents will help materially in reducing underground corrosion . . . .

▲ THE protection of underground cable sheath against corrosion is a subject which is of vital importance to all companies who maintain power or telephone cables in underground systems. This includes not only public utilities but other industrial concerns, including steel companies, who maintain this type of plant.

In a broader sense, the subject of corrosion should be of interest to all concerns who maintain any type of underground metallic structures. It has been estimated that the loss to American industry per year due to underground corrosion is in excess of one billion dollars, so that the potential field for worthwhile savings is very great.

The more common industrial metals with which we deal, such as iron, lead, copper, and aluminum do not as a rule appear in nature in their metallic state, but are found in chemical composition with other elements and these combinations are known as ores. When these metals have been separated from their ores and appear in what we know as the metallic state, they are far from stable and tend to return to their more natural state in composition with other elements. This process of returning to their natural state is known as corrosion.

All corrosion is electro-chemical; that is, it involves both electrical and chemical phenomena. Even in those cases where a metal is exposed to an acid solution and severe etching of the metal occurs, the process is still electro-chemical. However, in a case of this kind, the paths of the electric circuit will be short, being localized within very small areas of the metal.

Regardless of whether the chemical change is responsible for the current flow or the flow of current initiates the chemical change, the characteristics of the corrosion damage is the same, and a current flow of one ampere will in one year cause the loss of as much as 20 pounds of iron or steel, or 70 pounds of lead.

Corrosion may often be controlled in industrial processes through chemical means by selection of the electrolyte or metal used in the process. It is much more difficult, however, to control the chemistry of the electrolyte in which cable sheaths are more or less immersed, that is, the earth. As a result, the first line of attack in controlling cable sheath corrosion has been electrical.

There are a number of general types of corrosion which affect lead cable sheath. Among them are:

1. Stray current anodic corrosion resulting from the transfer of direct current from the sheath to the earth.
2. Stray current cathodic corrosion resulting from an accumulation of strong alkalis at the surface of the cable sheath due to a cathodic (negative) condition of the cable in soil containing alkali salts.
3. Localized anodic corrosion is caused by small local cells in which all or part of the cable sheath acts as an abode in an electrolytic of soil water. This type is known as non-stray corrosion.
4. Galvanic action involves two dissimilar metals in electric contact with an electrolyte. This type is also known as non-stray current corrosion.
5. Chemical attack can occur on cable sheath from certain acids or alkalis.

Until comparatively recent years, the type of corrosion with which we were most concerned in the telephone business was that due to stray currents where the cable sheath was anodic, (positive), to earth.

Corrosion occurs at the point where current leaves the sheath and flows into the electrolyte. Any current which leaves the sheath must have entered it at some other point and the problem then resolves itself into two equally important parts:

1. Limiting as far as practicable the current which enters the sheath.
2. Providing metallic paths through which the current may leave the sheath without damaging it or other metallic structures.

The principal cause of stray current in the earth is the ground return system of trolley lines. As shown in Figure 1, current from a generator is fed over a trolley wire to a car and returns over the grounded track. Part of the return current leaks from the rails to the earth at the car and some of this is picked up by the cable. In the vicinity of the car the cables are cathodic or negative to earth. Near the generator or point of attachment of a negative feeder to the track, some of the current on the cable leaves to return to the track. The cables at this location are anodic, or positive to earth. It is at this point that corrosion of the sheath occurs.

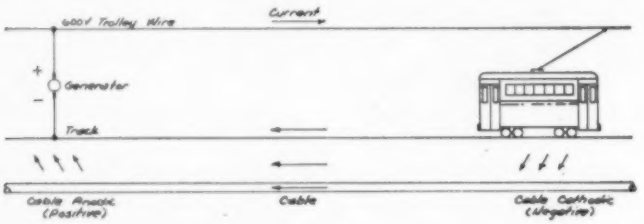


Figure 1 — One of the principal causes of stray currents comes from trolley lines where the track is used as one side of the circuit.

If this flow of current from the cable sheath to the earth can be prevented, corrosion is not likely to occur. Since it is not practicable to entirely insulate the cables so that the current will not be picked up from grounded rails, it is important that suitable bonding be provided at the point where the current tends to leave the cable so that the current will not leak off through the earth. Such bonding usually involves a metallic connection between the cable sheath and rail or negative return.

Measures which tend to reduce the amount of stray current from grounded rails are:

1. Increased resistance to the flow of current from the tracks through the use of ballast.
2. Reduction of potential gradient or voltage drop along the rails through the use of improved rail bonding and negative returns to increase the current carrying capacity of the return system.
3. Restricted use of metallic conduits for cables.
4. The use of corrosion protected cable or plastic (polyethylene) sheathed cables to prevent the cables from picking up stray currents.

Stray currents are also caused by faults in direct current distribution systems used in industrial plants including steel mills.

While many of these distribution systems are designed to be operated as isolated systems, that is without grounds, they frequently develop grounds, and as long as these incidental grounds are all on the same side of the line, no trouble is indicated in the power system. If an additional ground develops on the opposite side of the line, a trouble indication is received possibly in the form of a blown fuse, and the trouble is located and cleared. However, the other incidental grounds remain and these are potential sources of corrosion trouble on cable sheaths.

Figure 2 shows the path of the current from the faults through the cable sheath and return to the distribution system. Here again, the corrosion occurs at the point where the current leaves the cable sheath to return through the ground to the power conductor. Steps are necessary to prevent the current from getting on the cable sheath or to conduct it away from the sheath over a metallic conductor so that no damage to the sheath results.

Our experience indicates that in industrial plants it is extremely difficult to keep an electric distribution system free from grounds, and thereby limit the amount of stray current picked up by cable sheath. Remedial measures must therefore depend on providing a metallic path for the current at the point where it tends to leave the cable, and on the use of corrosion protected or plastic covered cable.

Stray current anodic corrosion may also be reduced through the use of forced drainage or cathodic protection. This is a method that may be used to reduce corrosion on underground structures by forcing current from the structure to a special ground by means of a separate source of potential, such as a battery or rectifier. The benefit is obtained either by lowering the potential of the cable sheath or by a combination of lowering the cable potential and raising the potential of the surrounding earth. Figure 3 shows a typical arrangement using forced drainage.

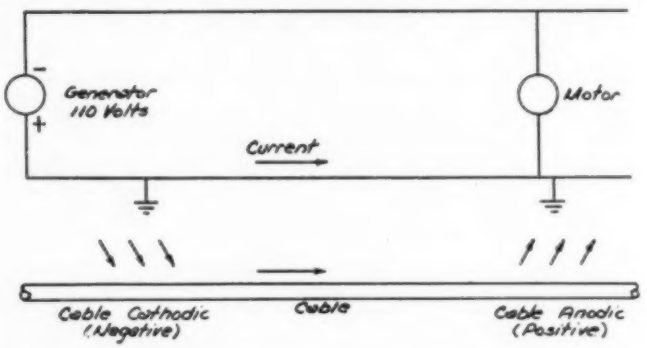
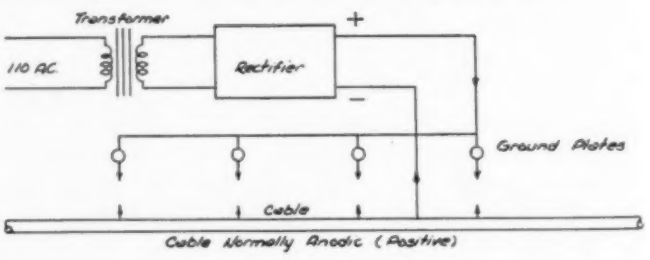


Figure 2 — Stray currents may also come from industrial supply systems.

Forced drainage or cathodic protection is particularly applicable on older structures because it can be applied with very little disturbance of the structures. Its application requires a continuous supply of direct current and anodes through which the current can be fed into the ground. Where larger amounts of current are required, they are usually supplied from a direct current generator or a rectifier. The anodes, which are

Figure 3 — Stray currents may be reduced through the use of forced drainage for cathodic protection.



buried at a suitable distance from the cable, are usually a number of carbon rods or a mass of scrap metal.

The anodes, regardless of type will be corroded by the protective current which they discharge into the soil and will require replacement periodically.

Forced drainage is also obtained in some instances through the use of galvanic anodes as shown in Figure 4. Magnesium anodes are buried along the route of the cable and a short distance, approximately 10 feet, away from the cable. The cable and magnesium anodes are then connected by insulated metallic conductors. The current in the electrolyte (earth) between the cable sheath and the magnesium anode, which together form a galvanic battery, is from the magnesium to the lead sheath, and this current tends to reduce the positive potential on the cable sheath. The magnesium anode is gradually consumed and must eventually be replaced.

Another form of corrosion found in stray current areas is known as cathodic or negative corrosion. This occurs in locations where the cable is rather highly negative to earth and where alkaline salts are present in the soil or electrolyte.

In our own experience this has occurred most frequently where sodium chloride or calcium chloride has been used on street railway switches for melting ice and snow. These salt solutions find their way into the underground duct system carrying the telephone cables, and in locations where the cables are negative to earth, corrosion occurs.

There are several different theories regarding the chemical reactions involved in this corrosion process. They are all rather complicated and for the purpose of this paper it is not necessary to explore them, but it is desirable to review the steps that may be taken to prevent this type of corrosion.

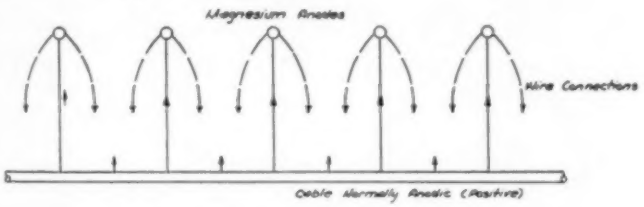


Figure 4 — Magnesium anodes are commonly used for cathodic protection.

The remedy for cathodic corrosion is to reduce, if possible, the negative potential of the cable sheath, prevent the formation of an alkaline condition in the soil, or use corrosion protected or plastic sheath cable. Laboratory tests indicate that cathodic corrosion cannot occur where the potential of the sheath is of less magnitude than 0.2 volts negative.

Alkalis can be removed from the ducts by flushing with water. This is done by plugging the ducts in one manhole and filling the adjacent one with water, then removing the plugs one by one from the ducts and allowing the water to run through. The amount of flushing required depends to a large extent on the amount of alkali present and the type of soil encountered. If the soil adjacent to the duct line is sandy, the ducts are flushed rather easily. Where clay type soil is involved, it has a tendency to stick to the cable in the ducts and requires considerably more flushing. This operation must, of course, be repeated each year after the winter season is over.

The foregoing discussion has had to do with corrosion due to stray electric currents often referred to as "man made" currents associated with street railways and power systems. Corrosion is also experienced in areas known as non-stray where the electric current involved is due to natural phenomena. The potential which produces these currents may be due to differential aeration, differential electrolyte concentration, or inhomogeneity of the sheath. This type of corrosion is local, although many such cells may exist along a cable so that a fairly long length of sheath may be corroded.

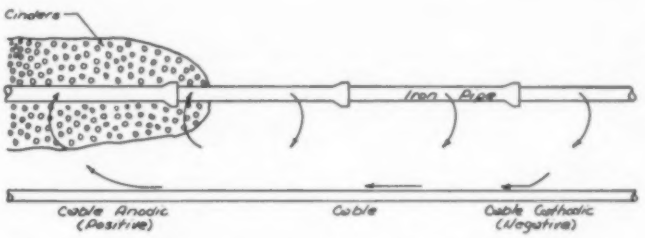


Figure 5 — Unburned carbon in cinders may set up battery action in the soil.

Currents in the sheath may also be caused by corrosion activity on paralleling pipe lines or as a result of a connection between the cable and a structure of dissimilar metal such as iron or copper water pipe.

Cinder fills have frequently been the cause of pipe and cable failures in industrial locations. As shown in Figure 5, galvanic action occurs in cases of cinders containing sufficient unburned carbon to act as a carbon electrode in contact with a water pipe or iron conduit. Local currents are set up between the cinders and the iron outside the cinder environment The iron pipe acts as the anode and the cinders act as the cathode. The cable being in the same environment simply acts as part of the electric circuit. The iron pipe is corroded outside the cinders where the current leaves it to travel through the ground or through the cable and the cable may be corroded where the current leaves it to return to the cinder cathode.

Cases of this kind can usually be remedied by removing the cinders from the earth and replacing them with clean soil.

One of the major differences between stray and non-stray current corrosion is in the magnitude of the currents and voltages involved. In the case of stray current areas, we are dealing usually with volts and amperes, while in non-stray areas the units with which we have to deal are milli-volts and milli-amperes.

Remedial measures applied in non-stray areas are generally similar to those used for stray current corrosion.

In addition to applying remedial measure, it is also very desirable that preventive measures be taken not only in connection with existing plant but also where the engineering of new plant is involved. This includes the selection of sheath materials and the location where the cable is to be installed. Filled ground containing chemically active materials should be avoided and adequate drainage should be obtained to eliminate

moisture from the duct line carrying the cables. Care should also be taken to see that waste matters are not disposed of where they may contaminate the soil in the vicinity of the underground plant.

Steps should also be taken to determine where corrosion might occur in existing plant and suitable remedial action should be applied.

The corrosion problem involves a large number of variables each of which may cover a wide range. The determination of whether or not corrosion is occurring or may occur and how to prevent it is a complex problem. While many data must be obtained to solve it, these data must be of the right sort and be carefully secured, and they must be subjected to careful engineering study.

In order to collect these data, periodic surveys of the entire cable plant are made and readings are taken of the voltage between cable and earth and between cable and other nearby metallic structures such as trolley rails, water and gas pipes, and any other underground metallic structures. Current readings are also taken to determine the amount of current that is flowing on the cable sheath and also the direction of flow of this current. Specially designed meters are available for taking these readings. In addition to the overall surveys, special investigations are made of trouble areas when necessary. Often these special investigations include 24-hour readings with recording meters to determine whether or not conditions vary at certain hours due to switching operations, and variation in power loads on the trolley or direct current power system.

After all of this data has been carefully analyzed, remedial measures are applied. These may include the installation of bonding wires to provide metallic returns for the current being carried on the sheath, the provision of negative boosters for forced drainage, the use of corrosion protected or plastic sheathed cables, and the construction of insulation joints in the cable sheath to interrupt the conducting path. It is, of course, of utmost importance that all efforts be made to limit the amount of current that is picked up by the cable sheath. This can be done by limiting insofar as possible all contacts between the cables and other foreign metallic structures.

And finally, it is highly important in all of our activities in this field, particularly where remedial measures are involved and especially where it may be proposed to install forced drainage systems, that we work in close cooperation with others who may have underground metallic structures in the same vicinity so that they may not be adversely affected by any action we may take.

The installation of a forced drainage system or a bond wire in one underground cable system may cause currents to flow in adjacent underground systems which would be detrimental to the second system unless proper coordination were secured. For this reason, all parties who may have plants in the vicinity of proposed remedial work should be kept advised at all times.

In many cities, committees made up of parties maintaining underground structures have been formed to act cooperatively on electrolysis problems. These committees meet regularly and discuss their common corrosion problems and arrange for joint action where this appears to be desirable

It should again be emphasized that the amount of money involved in damage due to corrosion is very great and that in addition, most cases of damage to pipe or cable are accompanied by service outages which will mean additional loss in time and money.

It is extremely important, therefore, that all parties concerned take an active interest in this work and cooperate with each other in order that the very considerable savings which are possible may be realized.

DISCUSSION

PRESENTED BY

WILLIAM E. COLEMAN, Research Technologist, Research and Development Laboratory, United States Steel Corp., Pittsburgh, Pa.

F. A. JOHANTGES, Electrical Engineer, Wisconsin Steel Works, Division of International Harvester Co., Chicago, Ill.

L. A. TERRY, Superintendent of the Power and Electrical Dept., National Tube Division, United States Steel Corp., Gary, Ind.

J. F. HEADLEE, Electrical Engineer, Construction Engineering Bureau, United States Steel Corp., Morrisville, Pa.

T. W. ALEXANDER, JR., Transmission Engineer, The Bell Telephone Co. of Pennsylvania, Pittsburgh, Pa.

William E. Coleman: Mr. Alexander has covered the problem of underground lead cable and in addition, has pointed out the correlated problem of buried steel structures. A steel plant has miles of one and tons of the other, so the potential savings mentioned in the paper are real dollars to large industrial plants as well as to public utilities.

Steel plants are particularly vulnerable to stray- current corrosion because of the large amounts of direct-current power that they require. We have tried to minimize this problem by operating our d-c systems clear of ground, but in spite of all precautions, faults will develop, and many of them are difficult to locate and correct. The best approach to overcoming this trouble is to recognize that it exists and to train our maintenance people to the extent that they are familiar with procedures for locating and eliminating sources of corrosion. Mr. Alexander's paper contains a number of suggestions that should help in this direction. One of these points follows the old battle saying, "If you can't lick the enemy, join him." In other words, if you can't eliminate stray-current leaks, provide a conductor to carry the undesired currents safely on their way.

Other phases of the subject, such as galvanic corrosion, chemical attack, and cathodic protection have been properly introduced and well discussed in the paper. The general problem does sound quite complex, but when analyzed more fully it is just another engineering problem. When treated with due respect, it can be handled by the steel industry just as well as many of

our metallurgical problems. There is much that we do not know about making steel, but each year we make larger quantities of better quality, so just because we do not know all about corrosion is no reason to turn our backs on it.

In closing, I would like to thank Mr. Alexander for his very informative talk and would like to again emphasize that the people of the steel industry must become conscious of the damage being done by underground corrosion and learn how to save dollars by fighting this enemy.

F. A. Johantges: Mr. Alexander outlines the problems that we have in protecting underground cable sheaths. In the first part of the paper, he divides these into two parts with reference to stray currents: first, to limit the current that enters the sheath and, second, to provide metallic paths through which the current may leave. In order to apply these to a steel mill where the underground cables may be relatively short and the power system is ungrounded, I would ask him for the best way to stop the current from entering the sheath, and the type of metallic path best for draining the current from the sheath. It seems as though we should try to limit all metallic contact between the cable sheath and other foreign metallic structures. Would grounding the sheath at regular intervals satisfy this protective requirement?

Two other questions that I have are: how much harm is likely to occur when the lead sheathed cable is enclosed in steel conduit underground, and what is a corrosion protected cable?

It is interesting to know that some benefit can be obtained by flushing the manholes and duct lines periodically in order to remove the alkalis.

Possibly Mr. Alexander will give us some more information on the use of magnesium anodes—can they be used to protect iron pipes carrying water or other liquids? Apparently this is an easy method of controlling corrosion.

L. A. Terry: Mr. Alexander has given us a very good and instructive paper on the fundamentals of corrosion and its prevention in underground structures and it is hoped that this paper will be published in our annual proceedings as a reference for steel mill engineers who may be having corrosion troubles.

It has been my experience and the experience of others in steel mills to presume that you have no electrolysis in your plant, until you have some trouble.

In our case, we kept the direct-current system free of grounds; the plant sets on dry sand so how could we have electrolysis? After a cable failure, we conducted a test and found that we had active corrosion from stray currents in our underground structures originating from a nearby plant. Periodic tests for electrolysis in any plant should be good preventive maintenance procedure.

J. F. Headlee: In our engineering and underground cable system at Fairless works, which I am connected with at the moment, we have seen fit to follow two of the schemes prepared in Mr. Alexander's paper: One, of first protecting the cable sheath with a neoprene jacket; second, using suitable anodes to divert some of the stray currents.

We feel that the work of putting on the neoprene jacket cable will prevent not only the stray currents due to faults in our d-c system, which surely are bound to occur sooner or later, but if and when it does you will not have every opportunity in the world to clear those. Again you have a certain amount of stray currents due to your electrochemical series. We feel it will do that, and to that end we have found it advisable and have carried out that plan of using the neoprene jacketed cable, which we trust and hope will eliminate some of our problems.

T. W. Alexander: One of the questions which has been asked is how to eliminate metallic contacts. That sometimes is a pretty tough job. You try to keep the cables as clear as you can from building structures, but it is pretty difficult to do that sometimes.

One of the ways that has come in to more popularity in the last few years has been the use of corrosion protected cable. That question was also asked: What is corrosion protected cable? Originally it was just a lead sheathed cable which had around it wrappings of sisal craft paper, and was impregnated with a bituminous compound to keep out moisture. It was not permanently waterproof; it was moistureproof, and it kept the moisture away from the cable for considerable periods of time, just how long we do not know, because our experience has been over relatively short periods of time, and we have had very few failures due to corrosion on those corrosion protected cables.

A later type of cable development has been the polyethylene covered cable, and that, of course, has a plastic cover instead of lead sheath. It has a thin aluminum sheath under the plastic which provides electrical shielding, and it has the plastic over this aluminum sheath.

Now, that is fine as far as corrosion protection is concerned. It has very high dielectric strength, and it keeps the electric currents from collecting or being collected by the cable. But, like everything else, it is going through a period of development. As soon as we learn how to build plastic covered cables we do not immediately junk all of the equipment that we had for building lead covered cables, and lead covered cables still have a very wide use. There are certain places where they are very much better than plastic covered cables.

The machine for making plastic covered cables are coming in more and more all the time; there is more of it being used. In fact, we had to find substitutes for the lead because we could not get enough lead to make all of the cable that was needed. But there are problems in the use of plastic covered cables, the same as any other new development. In the first place, it is much more difficult to make a water tight joint between two sections of the plastic covered cable, and there are other physical difficulties. We had trouble with the sheath cracking when it was first built. That was a chemical difficulty that had to be corrected in order to make plastic sheath cable that would not crack. Now that problem has been solved, and we are not having that trouble.

However, like any other development, these new devices come along slowly, and we are not using plastic covered cable in all of the places where we are having corrosion trouble by any means. There is the problem

of stocking cables. It takes a lot of space, and you do not stock all different sizes of cables. When you happen to have a cable failure due to corrosion you may not have the proper size plastic covered cable to put in that particular job, and you have to go back and use a piece of lead covered cable.

So those are some of the reasons why we are still using lead covered cable in places where you might ordinarily think we should use a plastic covered cable which would not collect electric currents.

The question was also asked about magnesium anodes for protection of iron pipe. They are used in the same manner for protecting iron pipes, as for lead cable and the oil companies which have these long pipe lines across the country are using them in large numbers. They bury these magnesium anodes along the pipe line after their studies indicate the locations where they are needed, and the pipe line is protected in the same manner as the lead covered cable, the direction of flow again being from the magnesium toward the iron, the same as it is from the magnesium toward the lead.

We are having varying experiences, speaking of grounds on these direct current power systems in mills. We have had varying experiences with the steel people. We appreciate that you people are in the business of making steel and not primarily in the communications business. We found in some cases steel people were willing to try these various methods for eliminating the collection of current and providing return paths at the return areas; in other cases they have been unwilling to admit that they had any grounds on their power system and were even willing to pay for the damage rather than to have some of these corrective steps taken.

The question was also asked as to the best way of providing a return path. What you usually do is connect a copper bond wire between the lead cable sheaths, or the underground structure that is to be protected, directly to the return path in the power system.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Saturday, May 23, 1953

Annual Picnic — Pearl Lake

Birmingham, Ala.

▲

CLEVELAND SECTION

Friday, May 15, 1953 — Dinner 6:30 P.M.,

Golf Party — Acacia Country Club

PITTSBURGH SECTION

Monday, May 4, 1953

INSPECTION TRIP — Bethlehem Steel Co., Johnstown, Pa.

Buses will leave at 1:00 P.M., from the Iron St. entrance.

Dinner — 6:30 P.M., — Sunnehanna Country Club, Johnstown, Pa.

Plan to Attend

1953 ANNUAL CONVENTION

HOTEL WILLIAM PENN

PITTSBURGH, PA.

SEPTEMBER 28, 29, 30, OCTOBER 1

PROGRAM

ANNUAL SPRING CONFERENCE

SPONSORED BY

The Rolling Mill Committee

OF THE

ASSOCIATION OF IRON AND STEEL ENGINEERS

STATLER HOTEL

MAY 18 - 19, 1953 BUFFALO, N. Y.

Annual Spring Conference

PROGRAM

HOTEL STATLER

BUFFALO, N. Y.

MAY 18, 19, 1953

ALEX MONTGOMERY, JR.

GEORGE A. HENDERSON

MONDAY, MAY 18, 1953
9:00 a.m. — Registration — Mezzanine — Floor Corridor
9:30 a.m. — Rolling Mill Session — Chinese Room

Co-chairmen:

Alex Montgomery, Jr.
Assistant to Vice President, Rolling Mills
United States Steel Corp.

George A. Henderson
Superintendent of Mills
Bethlehem Steel Co.

1. "Use of Oxy-Acetylene in Rolling Mills"
   R. L. Deily, Steel Mill Representative
   Air Reduction Co.
   New York, N. Y.

2. "Flying Shears for Billet, Bar and Rod Mills"
   E. S. Murrah, Electrical Engineer
   and
   J. H. Hitchcock, Director of Research
   Morgan Construction Co.
   Worcester, Mass.

HOTEL RESERVATIONS

WRITE DIRECT FOR HOTEL RESERVATIONS TO HOTEL STATLER, BUFFALO, N. Y., GIVING TIME OF ARRIVAL AND TYPE OF ACCOMMODATIONS DESIRED. RESERVATIONS SHOULD STATE THAT THEY ARE FOR AISE SPRING CONFERENCE.

J. H. HITCHCOCK

E. S. MURRAH

W. J. TUNNY

P. B. MANSFIELD

R. E. MARRS

A. W. SMITH

GEORGE KAUFMAN

LOUIS MOSES

9:30 a.m. — Electrical Session — Empire State Room

Co-Chairmen:
W. J. Tunny
Superintendent Electrical Maintenance
Youngstown Sheet & Tube Co.

Philip B. Mansfield
Electrical Engineer
Republic Steel Corp.

1. "Electric Systems for Hot Strip Mills"
   R. E. Marrs, Steel Mill Section, Industrial Engineering Department
   General Electric Co.
   Schenectady, N. Y.

2. "Electrical Equipment for the Jones & Laughlin Blooming Mill"
   A. W. Smith, Steel Mill Engineer
   Westinghouse Electric Corp.
   East Pittsburgh, Pa.
   and
   George Kaufman
   Chief Electrical Engineer
   Jones & Laughlin Steel Corp.
   Pittsburgh, Pa.

JAMES N. IMEL

2:00 p.m. — Rolling Mill Session — Chinese Room

Co-Chairmen:
Louis Moses
Mill Engineer
Bethlehem Steel Co.

James N. Imel
Superintendent, Strip and Sheet Department
Jones & Laughlin Steel Corp.

1. "A New Theory of Hot Rolling"
   G. S. Mican, Division Superintendent of Rolling
   United States Steel Corp.
   South Chicago, Ill.

2. "Mechanical Design and Operation of Jones & Laughlin's New Blooming Mill"
   J. H. Mayer, Assistant Superintendent Blooming Mills
   Jones & Laughlin Steel Corp.
   Pittsburgh, Pa.

3. "Roll Pass Design and the Rolling of Automotive Rim Sections"
   Howard H. Morgan, Assistant Roll Engineer
   Jones & Laughlin Steel Corp.
   Pittsburgh, Pa.

G. S. MICAN

ELD

J. H. MAYER

HOWARD H. MORGAN

E. T. W. BAILEY

A. F. KRITSCHER

A. L. LANCASTER

F. R. PULLEN

J. ROBERT LOTTES

2:00 p.m. — Technical Session — Empire State Room

Co-Chairmen:

E. T. W. Bailey
Chief Combustion Engineer
The Steel Co. of Canada, Ltd.

A. F. Kritscher
Development Engineer, National Tube Division
United States Steel Corp.

1. "Modern Automatic Fuel Shut-Off System for Soaking Pits While Charging or Drawing Ingots"
   A. L. Lancaster, Chief of Electrical Design
   Amsler Morton Corp.
   Pittsburgh, Pa.
2. "Soaking Pit Fuel Selection"
   F. R. Pullen, Fuel Engineer
   Bethlehem Steel Co.
   Johnstown, Pa.
3. "Design and Application of Bronze Slippers in Universal Couplings"
   J. Robert Lottes, Sales Engineer, National Bearing Division
   American Brake Shoe Co.
   Cleveland, Ohio

7:00 p.m. — Informal Dinner — Ball Room

Speaker: Stuart Armour, Economic Adviser to the President,
The Steel Company of Canada, Ltd.

TUESDAY, MAY 19, 1953

INSPECTION TRIP — The Steel Co. of Canada, Ltd.

Hamilton, Ontario, Canada

9:00 a.m. — Buses leave from Hotel Statler

Printed in USA

ABSTRACTS OF TECHNICAL PAPERS

FOR

Annual Spring Conference

May 18 - 19, 1953

Buffalo, N. Y.

FLYING SHEARS FOR BILLET, BAR AND ROD MILLS

By E. S. MURRAH
Electrical Engineer
and
J. H. HITCHCOCK
Director of Research
Morgan Construction Co.
Worcester, Mass.

▲ THE first flying shear, invented in 1893 by Victor E. Edwards, was a steam-operated machine designed to divide, into cooling bed lengths, billets delivered from a continuous mill at rolling speed. Although numerous refinements were made during the succeeding years, this original principle is still in very extensive use; in fact this type of shear remained in virtually undisputed possession of the field for more than half a century. With the replacement of steam engine drives by electric motors, leaving the shear as the only component of the mill which required steam in large quantities, demand arose for an electrically-driven flying shear.

Electrically driven flying shears have been employed extensively for shearing strip, both hot and cold, at mill delivery speeds, and in cold processing lines. However, the shearing of square or round sections at mill delivery speeds presents a number of requirements which are not encountered in shearing strip; in fact, the design of shears for this purpose is one of the most difficult problems to be found in rolling mill engineering.

This paper describes the design, control and performance of electrically-driven crank-type shears for billet, bar and rod mills. The first of these shears was put into operation in 1947. They have subsequently been applied to a variety of continuous mills. In shears of this type, the knives are rotated by two opposing crankshafts, and are guided by cam-operated tail rods which hold the knives parallel to each other and perpendicular to the bar during the cut, and which accelerate the knives to clear the path of the bar quickly after completion of the cut. Each shear is driven by multiple d-c motors supplied with power from a separate motor-generator set.

Although the control can be varied to meet special requirements, the usual pattern of operation is to accelerate the shear from rest to crop the front end of each billet, divide the billet in to uniform successive lengths by brief controlled retardation between cuts, and stop the shear after complete division of the billet.

This type of shear also lends itself admirably to the "crop and cobble" type of operation for bar and rod mills. The shear is placed immediately after the roughing mill, and crops the front end of each bar automatically, or divides the bar into conveniently handled scrap box lengths in case of a cobble in the finishing mill.

ELECTRICAL EQUIPMENT FOR THE JONES & LAUGHLIN BLOOMING MILL

By A. W. SMITH
Steel Mill Engineer
Westinghouse Electric Corp.
East Pittsburgh, Pa.
and
GEORGE KAUFMAN
Chief Electrical Engineer
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

▲ THE new 46 in. high lift blooming-slabbing mill at the South Side plant, Pittsburgh Works of the Jones & Laughlin Steel Corp. is driven by electrical equipment designed for fast operation. Fast operation could mean complicated, hard control, equipment but the main auxiliary drives give fast acceleration and deceleration without making the mill hard to operate. A compre-

hensive system of spare and emergency equipment is used to minimize downtime.

The 10,000-hp, twin-drive motor reverses the mill from 40 rpm to 40 rpm in only a second. This extremely fast change of speed is accomplished with rotating regulators and exciters with high forcing voltages.

High production depends to a large extent on the mill auxiliary equipment. A large part of the production time is used in auxiliary operations, such as changing the screwdown settings, positioning and turning the ingot, and bringing the ingot back to the mill on the tables and feed rolls. Adjustable voltage auxiliary drives give fast, easily controlled handling of the ingot and rapid, accurate positioning of the screws. Every effort has been made to insure a smooth flow of steel from the ingot cars through the mill to the slab piler.

The main drive motor-generator set and control are arranged so that one of the 2500-kw generators can be disconnected for maintenance or repair with only a slight reduction in the power that is available at the twin drive motor shafts.

An emergency generator and control are included to take the place of any one of the adjustable voltage auxiliary generators that is out of service. The circuit changes for emergency operation of the main and auxiliary drives are obtained by a simple arrangement of transfer switches.

The result is a mill and drive arrangement that is inherently capable of high production with a minimum of electrical maintenance and down time.

MECHANICAL DESIGN AND OPERATION OF JONES & LAUGHLIN'S NEW BLOOMING MILL

By J. H. MAYER
Assistant Superintendent Blooming Mills
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

▲ THE paper covers the recently completed 46-in. high lift slabbing-blooming mill at Jones & Laughlin Steel Corp., Pittsburgh works. It points out the "layout" and flow of product of this mill from the time ingots leave their open hearth shops to slab product in their blooming mill. Ingots are delivered to either of two soaking pit buildings, one in line with the mill which was also recently completed, and the other adjacent to the newly erected one. The system used in transferring ingots from the soaking pit building not in line with the mill is described, together with pertinent data covering the new soaking pit installation.

Main mill table, manipulators, screwdown and ingot buggies are on variable voltage that allows flexibility and speed of operation which is a large factor in high tonnage rates.

When ingots are delivered to approach table they are weighed and recorded. Slab product is similarly weighed and recorded immediately following slab shear. Both ingot and slab weighing operation is semi-automatic, being manually started with balance of operation following in proper sequence.

Both ingot and product scales, as well as other equipment were duplicated as much as possible on mill to reduce the necessary stock of spares.

Approximately six sizes of ingots are rolled weighing from 17,200 to 34,600 lb. Product shear is an up-cut, hydraulically operated shear designed with the possibility of "double converting" of ingots, and has a cross sectional area of 1000 sq in.

Delivery end of mill has two pushers, two pilers, and two slab pile "drag offs." Piles of slab product can be "stacked" to 48-in. in height, and are removed by crane equipped with rotating "C Hooks" to either rack cars, stocking area, or conditioning yard.

ELECTRIC SYSTEMS FOR HOT STRIP MILLS

By R. E. MARRS
Steel Mill Section
Industrial Engineering Department
General Electric Co.
Schenectady, N. Y.

▲THIS paper describes the most recent electric system for continuous hot strip mills. Notations are made of those components which contribute to uniformity in thickness and width of finished steel. Consideration is given to speed regulation of the finishing mill motors on a common bus by means of motor field adjustment. Various schemes of bus voltage regulation are described. The merits and advantages of a recent individual generator installation are outlined. A brief review is made on the use of mercury arc rectifiers both on a split bus arrangement and in parallel with existing motor-generator set equipments.

A NEW THEORY OF HOT ROLLING

By G. S. MICAN
Division Superintendent of Rolling
United States Steel Corp.
South Chicago, Ill.

▲THE principles which constitute the author's theory of hot rolling may be summarized as follows:

A new method for the construction of hot rolling pressure diagrams is derived. Base curves for noncumulative horizontal pressure effects are derived from an application of the shear stress theory. Cumulative horizontal pressure effects are superimposed on the base curves by applications of modified Prandtl equations. Limiting values of the pressure envelopes are established by the application of modified Prandtl equations which conform to the criteria of plastic yielding.

Contrary to prior concepts, when all other rolling conditions are held constant, progressive incremental increases in the coefficient of friction in the approxi-

mate value range of 0.3 to 0.55 result in incremental decreases in rolling pressures and decreasing trends for roll wear, roll breakage, power consumption, and surface tears of the rolled material. Incremental increases in the coefficient of friction in the range greater than the approximate 0.55 value result in the rolling pressure and related effects remaining constant at the minimums attained at the 0.55 value.

When all other rolling conditions are held constant, progressive increases in roll diameters result in progressively increased rolling pressures in general conformance with prior concepts. Trends for the surface tearing of the rolled material, however, decrease progressively with incremental increases in roll diameters.

In the development of the subject matter, the equations used in the construction of the quantitative pressure diagrams are first derived. The method of construction of the pressure diagrams is then explained, and subsequent illustrations depict the relationship between varying coefficients of friction and resulting rolling pressures for a wide range of rolling conditions. Several comparisons of theoretical pressure diagrams with actual pressure recordings made at the Kaiser Wilhelm Institute are indicated. Specific application of the theory to actual slabbing mill rollings is given. The concluding portion of the work develops the relation between varying roll diameters and surface tearing tendencies.

MODERN AUTOMATIC FUEL SHUT-OFF SYSTEM FOR SOAKING PITS WHILE CHARGING OR DRAWING INGOTS

By A. L. LANCASTER
Chief of Electrical Design
Amsler Morton Corp.
Pittsburgh, Pa.

▲ A close control of the firing conditions of a soaking pit is essential, if the pit is to yield uniformly heated ingots. Individual attention must be given to the fuel flow, combustion air flow, and pit pressure control systems in order to establish the ideal firing conditions for each pit. In addition, the individual combustion requirements will vary for each portion of the soaking pit cycle, namely the charging, heating, soaking and drawing periods.

As a background, this paper presents an introductory discussion of a typical control system, for use on a soaking pit during the heating and soaking cycles. The main body of the paper deals with the control of the firing conditions during the charging and drawing periods, when the balance of the control system is constantly upset by the removing and replacing of the pit cover.

The method of interrupting, and the sequence of restoring the normal firing conditions during the charging and drawing periods is discussed.

The details of a control system for use on a soaking pit installation where a "cab-operated" cover carriage is used to handle the pit covers, are compared to the details of the control system for use on those installations where a "remotely-controlled" type cover carriage is used.

DESIGN AND APPLICATION OF BRONZE SLIPPERS IN UNIVERSAL COUPLINGS

By J. ROBERT LOTTES
Sales Engineer
National Bearing Division
American Brake Shoe Co.
Cleveland, Ohio

▲ ROLLING mill stands in steel mills may be likened to other types of mechanical equipment to which an external source of power is applied. This external source may transmit its power to the equipment through shafting which may of necessity experience a change in direction. When this occurs, a break in the shafting is required, and the subsequent loose ends which are exposed are connected together by some sort of coupling device.

Original equipment manufacturers of rolling mill stands have designed and specified various types of couplings. In recent years the universal coupling has become the most widely used. The principal parts of the universal coupling are the jaw half coupling; the bearing segment assembly, which is made up of two bearing segments on the bearing pin, and the spade half coupling. These bearing segments are more commonly known as slippers.

Constant investigation is being made to improve not external design (or silhouette), but rather design factors, such as method of manufacture, and alloys in order to ultimately provide better service life. Three methods of manufacture are discussed. The term "method of manufacture" is used in this case to identify a resultant product:

1. Sand cast machined slippers.
2. Three-piece slippers.
3. Permanent mold slippers.

Some of the more common alloys which are currently used as slipper material will be discussed. These alloys are:

1. Phosphorous bronze.
2. Gear bronze.
3. Silicon bronze.
4. Manganese bronze.
5. Aluminum bronze.

The case histories which are discussed in this paper, point out the advantages resulting from proper alloy selection. Sound recommendations relative to a possible change of alloy or method of manufacture can only be made after a thorough investigation of the particular mill in question.

With labor and material costs higher today than they have been in the past, and with little likelihood of a reduction in the immediate future, this paper

should contribute to lower costs in slipper maintenance.

ROLL PASS DESIGN AND THE ROLLING OF AUTOMOTIVE RIM SECTIONS

By HOWARD H. MORGAN
Assistant Roll Engineer
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

▲ AS the title implies, the paper gives insight into a not too familiar product of the 12 to 16 in. bar mills rolling special shapes. Special emphasis is placed on the roll pass design of hot rolled pneumatic tire rim sections and hot rolled rim bases for solid tires. The roll pass design of a representative hot rolled pneumatic truck rim section used by each of four large rim manufacturers is discussed. The most common section troubles encountered in the rolling of rims, rolling tolerances, and their relation to pass design, are outlined. The designing of the passes, the making of the templates, and the turning of the rolls for rim sections are included.

A brief description is given of the Jones & Laughlin 14 in. bar mill and the rolling of rim sections on this mill.

SOAKING PIT FUEL SELECTION

By F. R. PULLEN
Fuel Engineer
Bethlehem Steel Co.
Johnstown, Pa.

▲ THIRTY holes of one way fired recuperative soaking pits were recently installed at the Johnstown plant of Bethlehem Steel Co. to heat steel for rolling on the new 46-in. high lift blooming mill. Many factors were involved in the selection of fuel for these pits, namely:

1. Location of pits.
2. Fuels available.
3. By-product fuel use in the entire plant.
4. Purchased fuel supplies.
5. Grades of steel to be heated.
6. Mill schedules.

After all of the above factors were considered and weighed, the decision was made to use low Btu fuel. Space limitations and other considerations influenced the selection of the type of pit furnace which could be built. The plant engineering forces and the pit furnace builders collaborated to design and build what is believed to be the first one-way-fired recuperative soaking pit employing high preheat air. These pit furnaces have been in operation for almost two years and are producing an excellent product with good operating performance.

WANTED!

There is a constant demand for copies of "The Modern Strip Mill", published by the Association of Iron and Steel Engineers.

If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

APPLICATION OF AUTOMATIC COMBUSTION CONTROLS TO A NEW OPEN HEARTH SHOP

By F. S. SWANEY
Combustion Engineer
Pittsburgh Works
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

. . . . close attention to small details by the combustion engineer secures continuous, reliable and low maintenance instrumentation . . . .

▲ONE of the most important features of the present expansion program at the Pittsburgh Works of Jones & Laughlin Steel Corp. is the new open hearth shop recently put into operation. The shop consists of 11 stationary furnaces rated at 250-net ton capacity. Iron is supplied to the furnaces from two 800-net ton capacity metal mixers. Present practice runs around 50 to 55 per cent hot metal. The port ends and roofs are of suspended basic brick construction with no dividing burner arch in the uptake (Figure 1). Combustion air is supplied to the furnace by a constant speed blower, the volume of air being controlled by means of louvers in the outlet of the blower (Figure 2). Air is preheated in single-pass checker chambers employing 7½ x 7½ in. vertical flues. Provision has been made for blowing the checkers down with steam. Draft for the furnace is provided by a 250-ft brick lined stack and is controlled by positioning a 6,000-lb water cooled, sliding damper. Soot blowers have been provided from the bottom of the checker chamber through the flue system to the stack in an effort to minimize flue dust build-up. Reversal of the furnace is accomplished by means of electrically operated, double-checked, water-cooled valves in the flue system. Provision has also been made in the waste gas system for the future installation of dust cleaning equipment if it becomes necessary. The furnaces are designed to fire steam atomized liquid fuel (residual tar or fuel oil) and coke oven gas up to 30 per cent of the total fuel input. Facilities for the use of oxygen for flame enrichment have also been provided. Figure 3 shows a view of the double barrel, artillery type burner used. The upper barrel fires the steam atomized liquid fuel. The lower barrel carries the oxygen and coke oven gas—oxygen in the center, gas on the outside.

Figure 1 — New shop consists of 11 stationary furnaces rated at 250 net tons.

Residual tar and fuel oil are supplied to the open hearth shop through two entirely independent circulating line systems at 225-psig pressure. The temperature in these lines is that required for pumping only as each furnace is equipped with its own individual reheater to further raise the temperature of the fuel to that required for atomization. With two separate pumping systems like this, it is possible to have any number of furnaces on either fuel at any particular time. Such flexibility permits much better control of plant fuel stocks. Each of the circulating liquid fuel lines has a pilot viscosity control unit installed on it. These units automatically control the viscosity of a small

Figure 2 — Volume of blower air is controlled by means of louvres in the outlet of the blower.

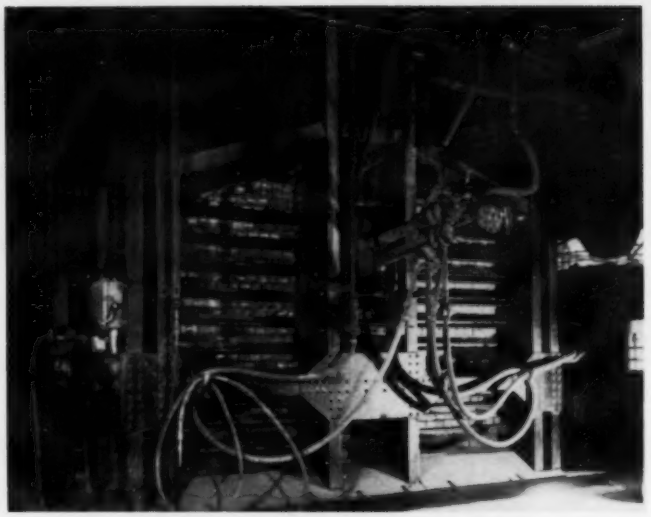


Figure 3 — A double barrel artillery type burner is used.

sample of liquid fuel and record the temperature at which this constant viscosity is attained. Thus, a continuous record is obtained of the temperature at which the individual furnace fuel reheaters should be set in order to attain the desired atomizing viscosity. Meter bodies are installed in the supply and return line of each circulating fuel system. These two flows are shown on a single circular chart with the instrument also integrating their difference, thus affording a continuous check on the total shop liquid fuel consumption. The circulating liquid fuel lines from the pump house to the open hearth shop are of such length that the steam tracer line is divided into two separate sections, each section under independent temperature control.

At the present time steam is available from the plant system at 150 psig and about 100 F superheat with the prospect of this going to 250 psig in the near future. Steam used from this system for atomization is preheated through superheaters located in the main flue ahead of the main stack damper. Oxygen for combustion, as well as carbon reduction, is available at 175 psig.

Coke oven gas is available to the open hearth shop in two independent lines. One large line carries gas at 40 oz for use on the furnaces as a melting fuel. Gas for spouts, ladles and other auxiliaries is supplied through a smaller low pressure (8 to 10 oz) line. The pressure in both these lines is automatically controlled and the flows are recorded and telemetered to the office of the gas dispatcher for his information. Compressed air used on all instruments and controls passes through a water-cooled, cartridge type filter and an automatically regenerative chemical type dryer. The dew point of the resulting air is below a —20 F.

The first problem encountered in the application of instrumentation to the open hearth furnaces proper was that of deciding what functions it would be desirable to record, control or operate. After due consideration of the latest equipment and techniques available, as reported from other plants and viewed in the light of our own experience, the following list of control functions was decided upon:

1. Liquid fuel flow control.
2. Gas flow control based on per cent of total fuel input.
3. Roof temperature control based on a closed end target tube located in the furnace roof.
4. Furnace pressure control.
5. Atomizing steam pressure control.
6. Fuel air ratio control including coke oven gas and oxygen used for combustion. With no personal operating experience to judge by, it was difficult to reconcile the conflicting reports from other shops on the value of this type of control. It was decided to adopt it, however, and operating experience to date has been most satisfactory.
7. Automatic reversal based on either time or temperature difference as measured in the checker outlet flues. It was also thought necessary to provide interlocks on the fuel flow control, the combustion air flow control and the furnace pressure control so that these variables could be artificially repositioned during reversal.
8. Checker temperature recorder. This recorder to also furnish record of superheated steam temperature and stack temperature.
9. Flow recording and integration on all fuels, steam and oxygen with the added refinement of pressure compensation on the oxygen flow record.
10. Flow record of total fuel and total air.
11. Liquid fuel temperature control.
12. Bath temperature recording.

After these control functions had been selected, the following factors were considered in selection of control circuits, type of equipment, layout, panelboard design, etc.:

1. In the interest of good housekeeping and in order to reduce fire and explosion hazard, it was decided that no oil or gas lines would be permitted in the control houses.
2. All equipment selected was judged with an eye to reliability of operation, ease and simplicity of maintenance and minimum number of wearing parts.
3. The control equipment and circuits should be so designed that the instrument repairmen would be able to service it with the minimum amount of help from other crafts. Our experience has been

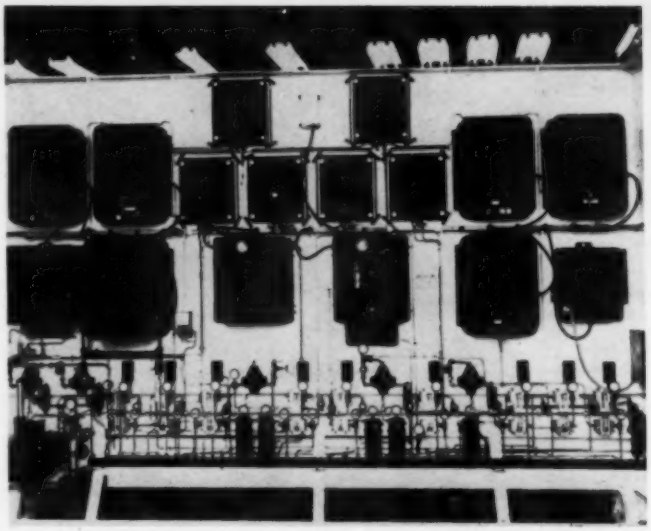


Figure 4 — The instruments were mounted, piped and wired to the terminal blocks at the factory.

that maintenance involving interlocking crafts unduly prolongs instrument outages.

4. It was thought highly desirable that all recordings possible be made on 24-hr circular charts so as to be available for daily scrutiny.
5. The liquid fuel metering and control system should provide for a ready swingover from fuel oil to residual tar or vice versa with a minimum amount of time required for resetting and recalibration.

Consideration of the aforementioned factors resulted in the selection of equipment which is basically pneumatic and electric. All flows and pressures are measured, transmitted, recorded and controlled pneumatically. All temperatures are measured electrically and recorded electronically. The automatic reversal system is basically pneumatic with electrical interlocks and relays where necessary. Since only wiring and air lines enter and leave the control house, it was possible in panelboard design to utilize the terminal block idea on the air lines as well as electric lines. Figure 4 shows a rear view of the panelboard, with instruments mounted, piped and wired to terminal blocks at the factory. It is believed that this results in a much neater job than is possible in the field.

The panelboard itself is housed in the first floor of a two-story control house located beside the reversing stand as shown in Figure 5. All recorders and indicators on the panelboard are clearly visible to the furnace operator through the glass windows which help to form part of the front wall of the control house. This is better shown in Figure 6. On the extreme left of the control house front face are mounted five pushbutton stations for operation of the motor operated furnace doors. Mounted below the front windows and recessed in the front wall of the control house is an inclined console-like panelboard which mounts all the controls necessary for the operation of the furnace. The layout of the panelboard and the console was dictated by a desire to provide convenience, readability and ease of operation for the first helper.

On the left third of the console is all the equipment —switches, pilot light, timers, etc.—necessary for reversal of the furnace. The reversal may be initiated on the basis of either time or temperature difference, as desired. Reversal itself may be accomplished automatically, that is, unattended, or semi-automatically, in which case the operator completes reversal by pressing just one switch after being warned by a horn that the time interval or temperature difference has been exceeded. The shut-off valves on the liquid fuel, coke oven gas, atomizing steam and oxygen lines may be also individually manipulated by the operator if he so desires. The automatic reversal system is provided with interlocks to prevent both firing on the wrong end and liquid fuel coming on without atomizing steam flow. In the case of a violent reaction in the furnace body from hot metal or metallurgical additions, the first helper, by manipulating a "blow" switch on the console can shut off the fuel and combustion air and raise the stack damper. This feature has proved quite popular in the new shop and is used frequently by the operators.

The center third of both the console and the panelboard is the operating heart of the combustion control system. From this section of the console, the first helper can set his total fuel input, the per cent coke oven gas desired, atomizing steam pressure the fuel-air ratio

Figure 5 — Panel lid is located on the first floor of a two-story control house.

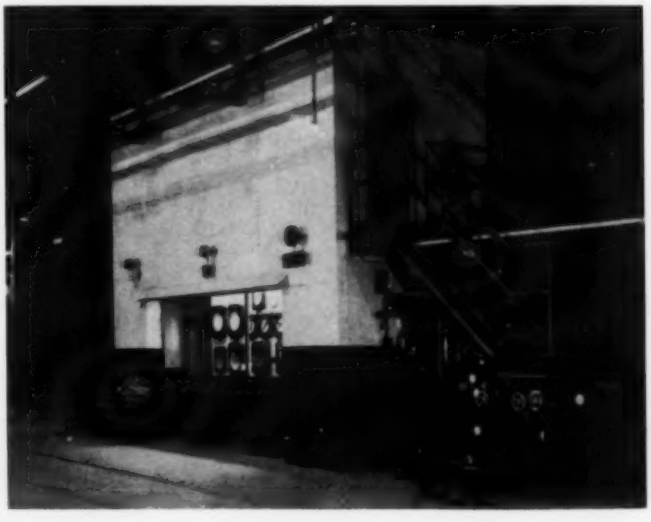
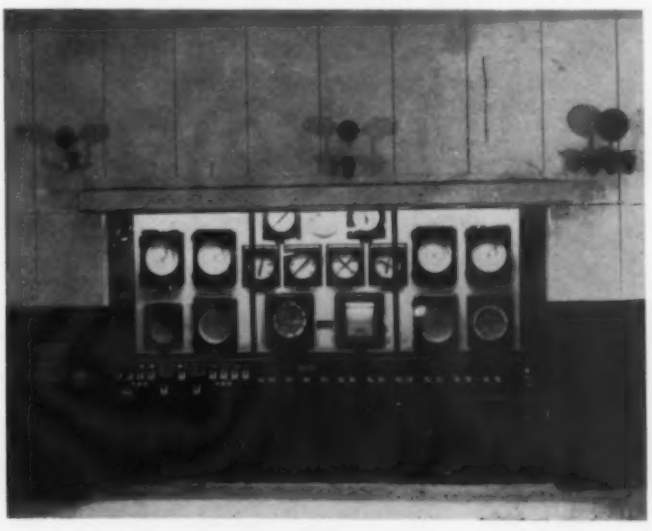


Figure 6 — All recorders and indicators are visible through glass windows in the front of the control house.



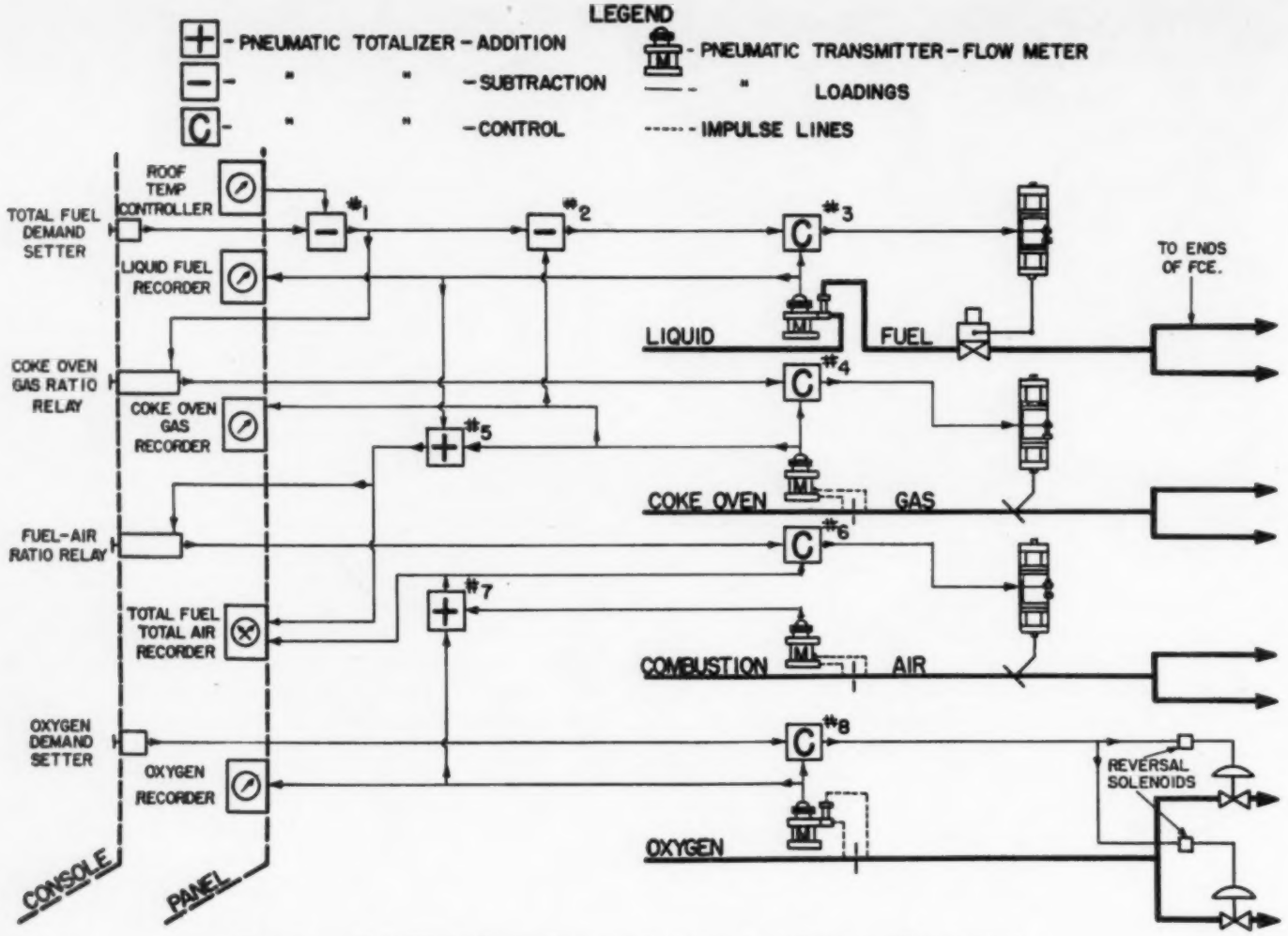


Figure 7 — Simplified schematic current of open hearth combustion control.

desired and furnace pressure and oxygen flow. Any adjustments the operator makes on any of these six variables of furnace operation are immediately visible on the six, square-cased, duplex indicators mounted on the panelboard around the clock. One duplex indicator shows the total fuel (liquid fuel plus coke oven gas) and total air (combustion air plus oxygen). Another duplex indicator shows the atomizing steam pressure at both ends of the furnace. The four remaining gauges indicate liquid fuel flow, gas flow, oxygen flow and furnace pressure. Each of the last mentioned indicators has a red pointer which indicates the desired value of flow or pressure desired by the first helper. On top of each of these red pointers and mounted on the same shaft is a black pointer which indicates the actual value of the variable involved. Thus, in normal operation, all the black pointers line up over and cover the red pointers, indicating all conditions satisfied. Abnormal operating conditions or malfunctioning of equipment is readily evident when the red pointers become visible. Immediately below the indicators is the roof temperature recording controller and the bath temperature recorder, both important to furnace operation.

The quantities indicated on the center part of the panelboard are recorded and integrated as necessary on the instruments occupying the left and right hand thirds of the panelboard. In addition, there is provided a liquid fuel recording temperature controller and a six point, round chart, temperature recorder measuring flue temperatures, differences, superheated steam and stack temperatures.

The right hand third of the console contains manual stations to provide for emergency positioning of the control valves for liquid fuel, gas, oxygen and air in the event of failure of the automatic control equipment. At the extreme right of the console are a push-button station and pilot light for the combustion air fan. Although not visible in the picture, hooks have been provided in the front wall of the control house immediately above the windows so that steel plates can be hung to protect the window and console during furnace rebuild. The bell, horns, and lights mounted above the window line on the front of the control house are alarms for semi-automatic reversal, high temperature roof alarm and a signaling device used on the bath temperature recorder.

A simplified schematic circuit of the furnace combustion control is shown in Figure 7. Manipulation of the total fuel demand setter causes a pneumatic signal to be impressed on No. 1 totalizer. Here it is combined with a pneumatic signal from the roof temperature controller. The output of No. 1 totalizer, therefore, represents total fuel demand with roof temperature cutback, and this output is impressed on totalizer No. 2. Here this total fuel demand, less roof temperature, is further reduced by a signal representing coke oven

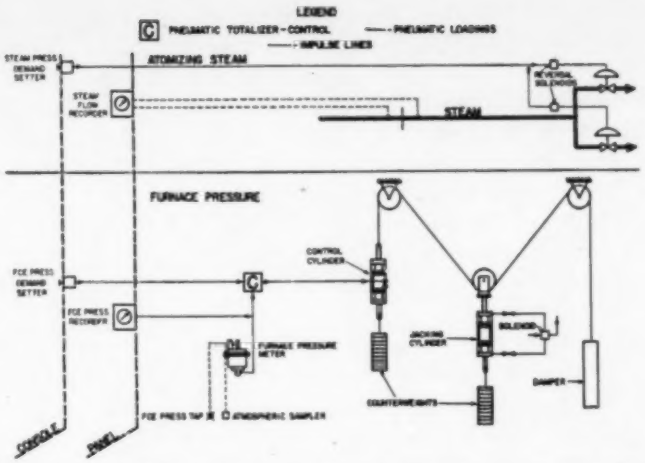


Figure 8 — Schematic circuit of controls on atomizing steam pressure and furnace pressure.

gas flow, if any is being used. The output of No. 2 totalizer, therefore, represents total fuel demand, less roof temperature cutback, less coke oven gas flow. This output serves as a demand signal on No. 3 totalizer, which acts to position the liquid fuel control valve so as to satisfy this demand. The liquid fuel meter sends out a pneumatic impulse which serves to rebalance the flow control totalizer No. 3 as well as an input to the liquid fuel recorder. The output of No. 1 totalizer also serves as an input to the coke oven gas ratio relay. This device sends out a pneumatic loading which is proportional to the input, this ratio being readily adjustable by the operator. This output is sent to No. 4 coke oven gas flow control totalizer, which in turn, modulates the flow of coke oven gas to satisfy the demand signal from the coke oven gas ratio relay. The coke oven gas is metered in turn, and the pneumatic signal representing it rebalances No. 4 totalizer and also serves as an input to the coke oven gas flow recorder. The outputs of both the liquid fuel meter and the coke oven gas meter are combined in totalizer No. 5. The output of this totalizer, therefore, represents total fuel and is so recorded on the total fuel meter. The total fuel output signal of No. 5 totalizer is also impressed on the fuel air ratio relay. This relay, again readily adjustable by the operator, serves to send out a pneumatic loading proportional to the total fuel signal, which is impressed on No. 6 combustion air flow control totalizer. This totalizer, in turn, repositions louvers in the combustion air duct so as to satisfy this demand for air flow. Manipulation of the oxygen demand setter results in a pneumatic loading being impressed on No. 8 oxygen flow control totalizer, which in turn, repositions pressure reducing valves at the ends of the furnace to satisfy this demand for oxygen flow. The oxygen flow is measured by the oxygen flow meter which impresses a pneumatic signal proportional to oxygen flow to rebalance No. 8 flow control totalizer. This signal also goes to the oxygen recorder and to No. 7 totalizer, where it is combined with the output from the combustion air meter to give a recording of total air.

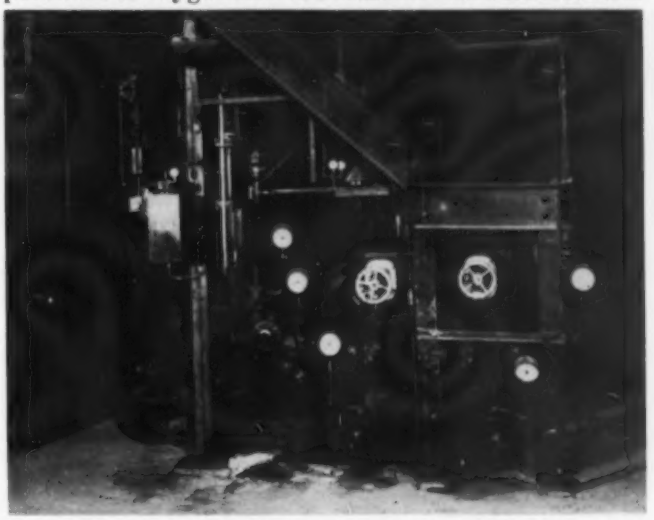


Figure 9 — The manual reversing stand for liquid fuel and steam is located adjacent to the control house.

Figure 8 shows a schematic circuit of furnace controls on atomizing steam pressure and furnace pressure. The atomizing steam pressure circuit is largely self-explanatory. The use of two cylinders in the furnace pressure control diagram might merit some explanation, however. As originally designed, the 42-in. damper control cylinder was installed double-reeved in order to get a seven foot lift on the damper. Operating experience disclosed the fact however, that the damper normally operated at something less than 25 per cent open and

Figure 10 — These reversal shut-off valves are for the liquid fuel and steam.

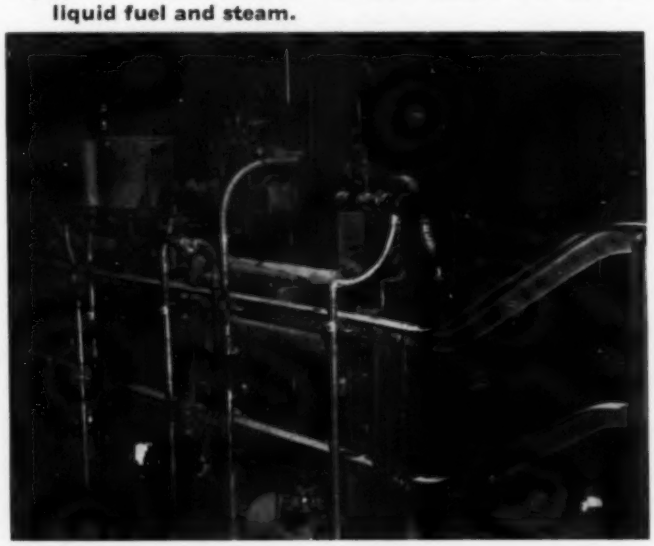
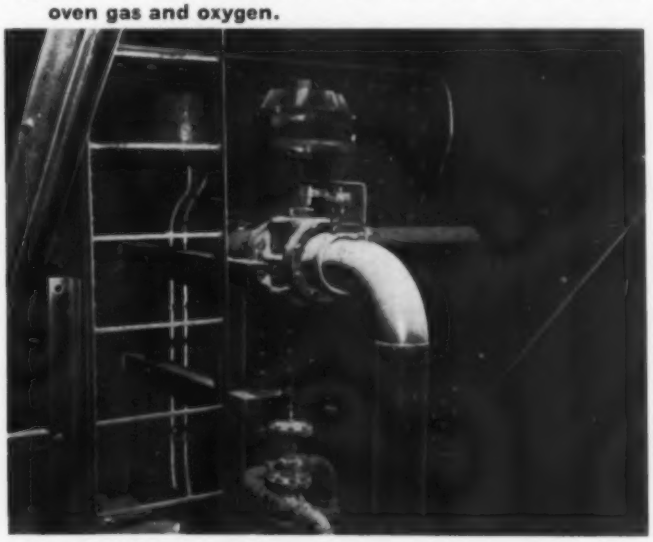


Figure 11 — These reversal shut-off valves are used on coke oven gas and oxygen.



that changes in damper position of something less than ½ in. resulted in considerable changes in furnace pressure. Due to both the high height of the stacks and the low pressure drop through the waste gas system, these factors, together with the heavy weight of the damper, 6,000 lb, placed too heavy a load on the positioning accuracy of the cylinder to permit good furnace pressure control. Thus, it was decided to single-reeve the control cylinder and position the damper over the lower half of its travel only. Full damper travel was accomplished by the addition of a two-position jacking cylinder which

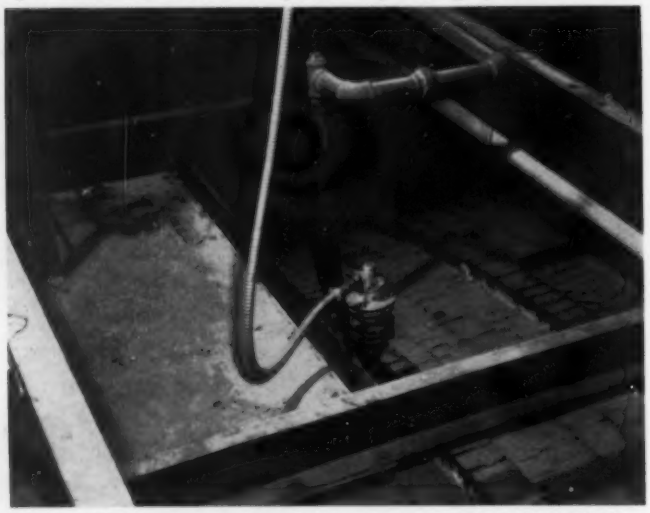


Figure 12 — Roof temperature is measured with radiation type instruments.

is actuated only during reversals or by the "blow" switch on the console.

Figure 9 shows a view of the manual reversing stand for liquid fuel and steam located adjacent to the control house. Also visible in the picture are the control cylinder positioning the liquid fuel control valve and the liquid fuel meter. Calibration of the liquid fuel meter is accomplished without opening the liquid fuel line and requires only a slight preset adjustment when swinging from fuel oil to residual tar, or vice versa.

Figure 10 shows a view of the reversal shut-off valves used on liquid fuel and steam, while Figure 11 shows those used on coke oven gas and oxygen. Those used on liquid fuel and coke oven gas are a vane-type, air motor mounted on a lubricated plug cock. The valves used for atomizing steam and oxygen shut-off are single-seated pressure-reducing valves, diaphragm-loaded, which permit them to be used for control valves as well as shut-off valves, thus eliminating two control valves from the system. The can-like covers shown in each of these two figures house the solenoid valves which actuate these pnuematic operators.

Figure 12 illustrates the radiation type roof temperature measurement installation on these furnaces. As can be seen, maintenance is simplified by the fact that there is no cooling water or compressed air required for this unit. Only electric lines run between this radiation unit and the recorder mounted on the panelboard.

Figure 13 shows a chart taken from the roof temperature recording controller. This furnace operated with the control point set at 3000 F.

Figure 14 is a chart record of the total fuel and total air flow. The cutback of fuel input from roof temperature control is clearly visible between 7:30 and 8:00 pm and again between 9:00 and 9:45 pm. The action of the fuel air ratio control is also evident during these periods.

Figure 15 shows a chart record of furnace pressure obtained from one of the furnaces in the new shop.

Figure 16 illustrates the record obtained from the six point temperature recorder. The butterfly type record obtained between 800 and 1200 F represents the temperatures of the thermocouples in the checker flue outlets. The more or less steady record at the top part of this butterfly is the temperature obtained in the stack. The spoke-like recording between 0 and 500 F represents the checker temperature difference. The steady temperature record at about 560 F represents the temperature of the superheated steam.

Figure 17 illustrates the type of chart record ob-

Figure 13 — Chart shows record of roof temperature for one day, January 18, 1952.

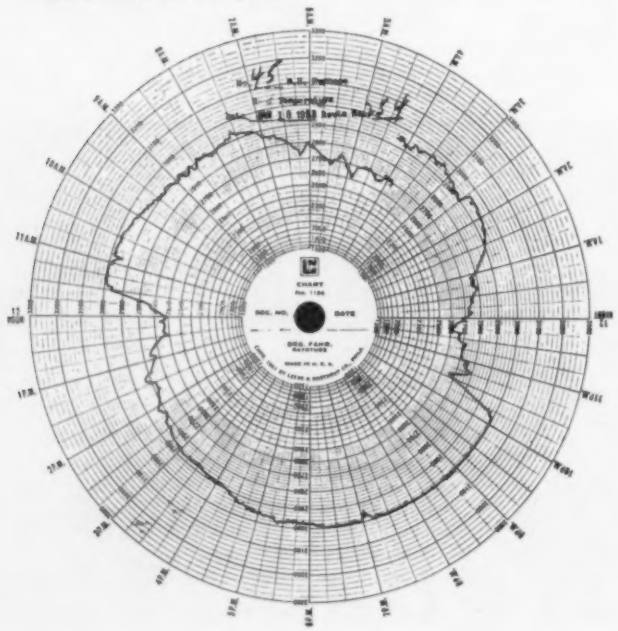
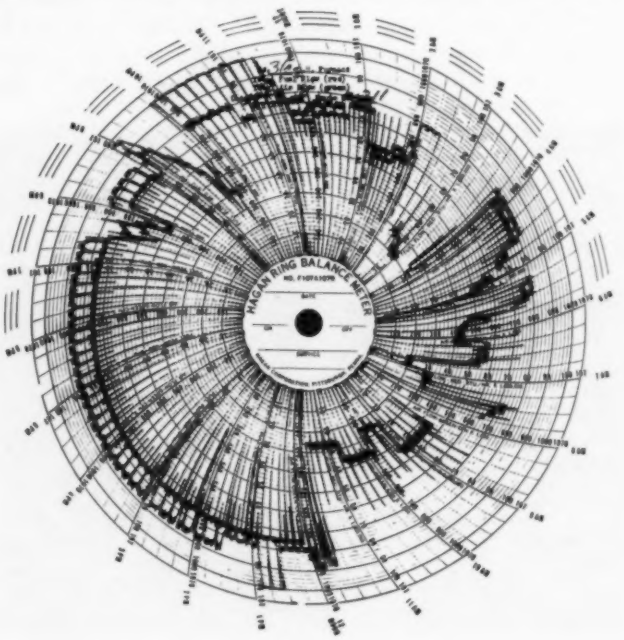


Figure 14 — Chart records give total fuel and total air flow.



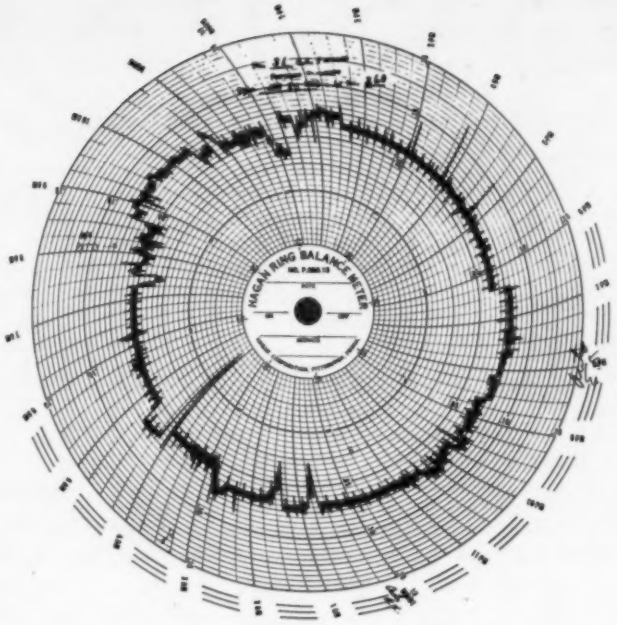


Figure 15 — Chart gives furnace pressure for No. 31 open hearth for one day, January 26, 1952.

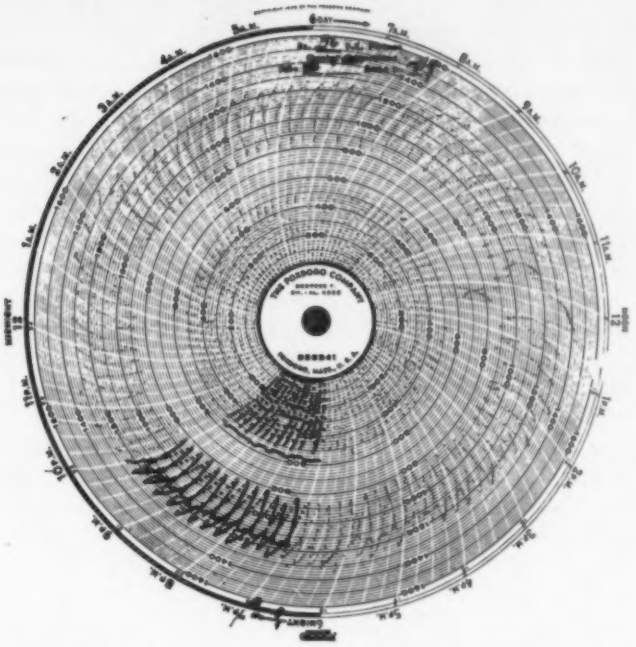


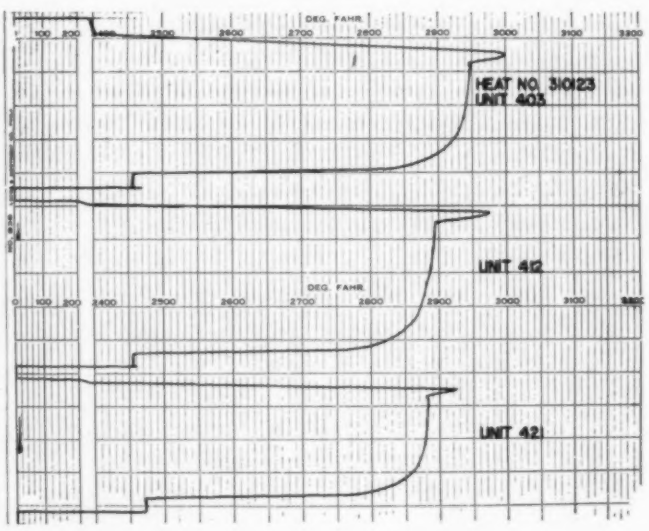
Figure 16 — Chart shows record obtained from a six-point temperature recorder.

tained by use of the immersion thermocouple. Three successive readings are shown on one heat, with the increasing temperature trend clearly shown. The abbreviated vertical trace at 2450 F on each reading is a record of the instrument automatically standardizing itself before the reading proceeds.

Although the control and instrumentation of these new open hearth furnaces was only a small part of the total open hearth project, any person who has ever been involved in this type of program will fully appreciate the time, thought, energy and experience that went into the design and installation of a project like this. Representatives from the engineering, operating and fuel departments and the furnace builders cooperated closely in the selection and design of all equipment. Most of the major pieces of equipment were either veterans in our plant experience or were given plant tests of upwards to six months in length before their selection was determined. At one stage of panelboard layout design, a mock panel was fabricated of plywood, on which were mounted full size, colored reproductions of the various recorders and indicators. These were then shifted around at will in order to get the best possible panelboard layout. When the panels and consoles were almost finished at the factory, a special trip was made to inspect, criticize and change where necessary.

Combustion engineers are ofttimes criticized for their close attention to small details, but we believe this to be the only way to secure continuously reliable, low maintenance instrumentation which will earn the respect and confidence of the operating personnel.

Figure 17 — Chart shows temperature given by immersion thermocouple.



DISCUSSION

PRESENTED BY

JOHN R. GREEN, Manager Steel & Ceramic Division, Brown Instrument Div., Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

F. S. SWANEY, Combustion Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

M. J. BOHO, Vice President Sales, Hagan Corp., Pittsburgh, Pa.

John R. Green: Since this is the first installation—at least that I know of—where an external console has been provided for the operators, rather than a direct setting of the control instruments, I am wondering whether experience to date has indicated that this method of setting is actually desired, and is justified by the cost.

Since I have just returned from seeing installations in England and Holland, there are some things in connec-

tion with open hearth control operations which might be of interest.

In the work which is being conducted at Ijmuiden, Holland, on radiating properties of flames, the over-all consensus of that work today is that the most important factor in improving flame radiation is the velocity at the burner. This brings us back to the type of control system described in this paper where the means of controlling is by pressure of oil and steam. There does not seem to be the relationship which was earlier reported between pounds of steam and gallons of oil as governing the high radiating power.

The other factor which is interesting is that in England, there are several shops that are actually using roof temperature measurements from three separate and distinct elements in the roof to do the controlling of the fuel during the major portion of the heat. The fuel input is set to the maximum which the furnace can take, and from that point on the fuel is cut down by the highest of the three roof temperature measurements. Whether we can ever maintain that type of equipment in the States, I do not know. The reports to me were that one man on each turn per shop did the maintenance work on this type of system.

F. S. Swaney: In regard to Mr. Green's question on the desirability of the console type of control operation, it may be said that we are very well satisfied with the way this type of construction has worked out. It permits ready adjustment of any of the controlled furnace variables and at the same time houses all control and recording equipment in a pressurized, relatively clean control room. This has reduced maintenance considerably.

M. J. Boho: We feel that Mr. Swaney and his associates used excellent judgment in their approach to the design of this control and instrumentation system. Since the measure of success they enjoy will depend on the results they get during the useful life of the equipment and, since those who use it are involved heavily, it seems logical to get the ideas of the furnace operators before fixing a panel design. It is interesting to note that the first helper considered the flow and pressure indicators of primary importance and wanted them grouped conveniently at one point where all could be viewed at once, while the recorders were relegated to a position of lesser importance at the ends of the panel.

This is not true of operators in other fields, say the refineries or the power plants, where recorders are considered by the operators to be of first importance.

Quite possibly, the fact that the first helper may wish to stand at the furnace and observe furnace operation and mentally evaluate this impression with the various indicator readings which he can see from across the charging floor had much to do with that preference.

STOVE FOR HEATING BLAST FURNACE AIR TESTED BY BUREAU OF MINES

▲ AN improved stationary-bed type of pebble stove — used to preheat air before blowing it into an experimental blast furnace — at temperatures reaching 2300 F, is described in a Bureau of Mines report released by Secretary of the Interior Douglas McKay. The improved stove is one of the most direct and economical devices for reaching such high temperatures rapidly and without damaging retort walls. The model, which was designed and built by the Bureau, involves an automatic reversing of the air stream by thermal control.

The stove was designed by Percy H. Royster of the Bureau's Washington headquarters and was constructed and operated as a cooperative project between the American Iron and Steel Institute and the Bureau for recovering manganese from open hearth slag.

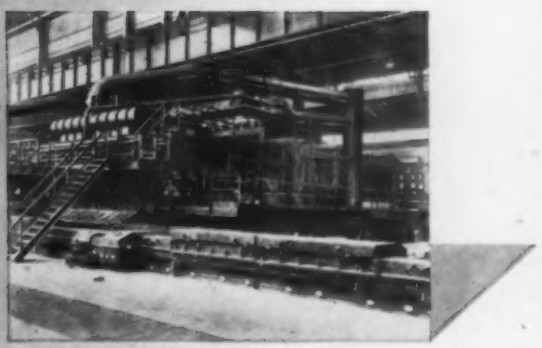
The pebble stove consists of a chamber lined with mullite brick and filled with pure alumina pebbles about 1 in. in diam which act as the heat-exchange medium. As pebbles disintegrate, new ones can be added during the operation — thus increasing heat efficiency. The report states 500 cu ft of air per minute is heated in this fashion before being blown into the experimental blast furnace. This type of operation with the pebble stove has never been used with a full-scale blast furnace.

The refractories used, alumina pebbles, are largely responsible for providing the higher temperature service. The general practice of ordinary stoves is to give a heated air of 1000 to 1600 F to the blast furnace. Moreover, the Bureau's heater has been designed to give the desired rate of air flow.

Prepared by R. C. Buehl, chief of the Bureau's Ferrous Pyrometallurgy Section, J. P. Morris, chemist, and J. P. Riott, metallurgist in the same section, stationed at Pittsburgh, the report shows a diagram and several charts of the stove's performance.

A free copy of Report of Investigations 4949, "Pebble Stoves for Heating Gases to High Temperatures," can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes St., Pittsburgh 13, Pa.

LOOK TO RUST FOR FURNACE EFFICIENCY



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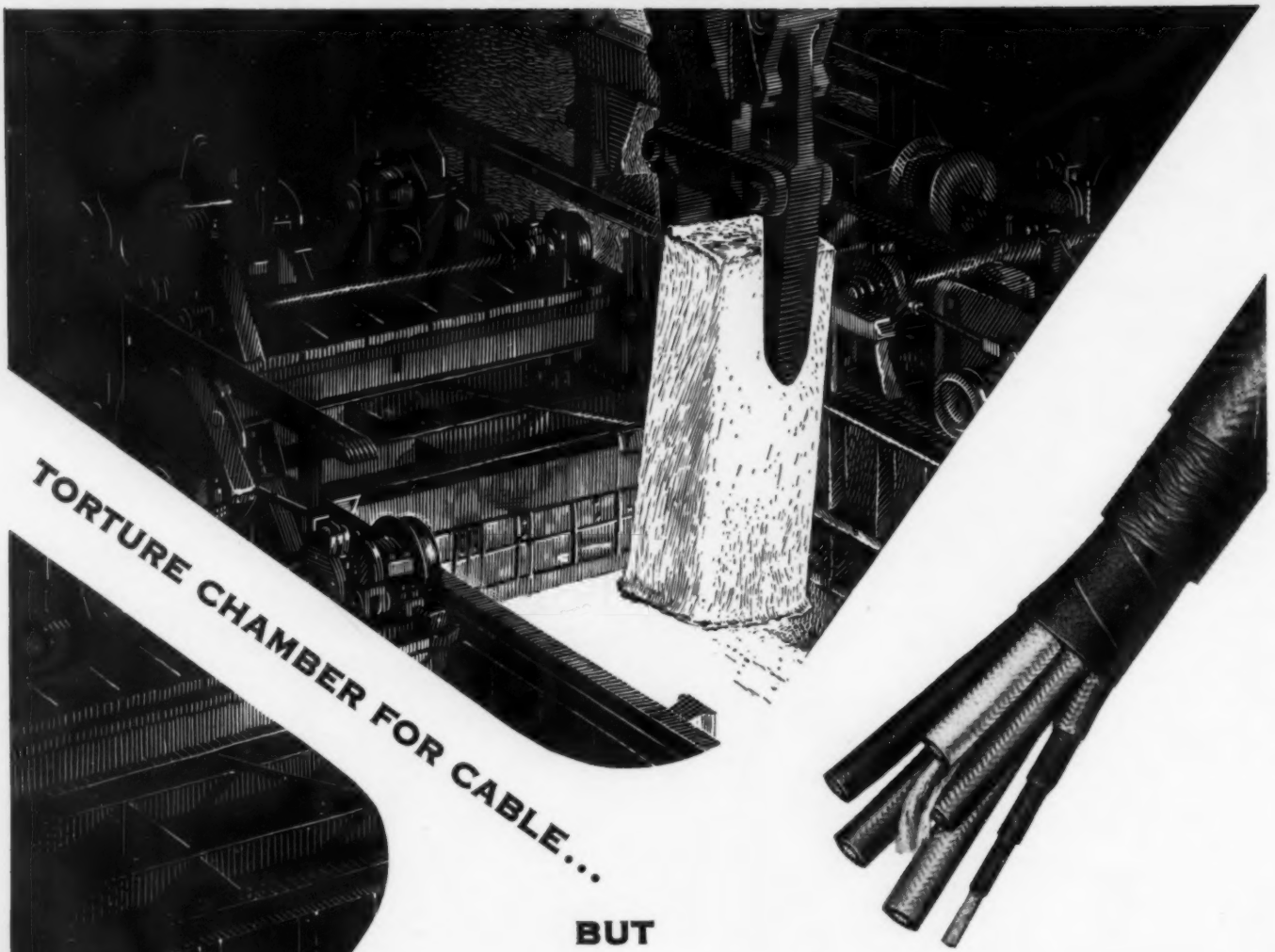

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IRON ORE RECOVERED FROM BLAST FURNACE GAS

By W. A. WALTON
Apparatus Department
Dravo Corp.
Pittsburgh, Pa.

▲ THE Jones & Laughlin Steel Corp. recently completed a modern blast furnace flue dust recovery plant for its Aliquippa Works, Aliquippa, Pa. The last word in dust collection, the system provides complete recovery of high iron-content dust as well as conforming to the Pennsylvania State Department of Health Clean Streams Program.

The plant is designed to handle a flow of 16,000 gpm of washer water containing approximately 100 gr per gal of flue dust with an iron content of about 45 per cent (dry basis). The flue dust is removed from the water and thickened to about 50 per cent solids. Overflow from the thickeners, with more than 95 per cent of the solids removed, is discharged to the Ohio River. The thickened slurry is pumped to a filter house, where it is fed to one of two disc type filters. Here it is filtered and the final cake, produced at a rate of approximately 65 tons in eight hours (wet basis,) is delivered to the sintering plant. This equipment has a rated capacity of 100 tons per eight hours.

The original dust collection system consisted of gravity flow of wash water from the blast furnace area to a large U-type settling lagoon where a large percentage of the solids settled out before the water overflowed into the plant sewer. This method was expensive in that it required continual clam shelling of the muck from the lagoon and loading it into railroad cars for the trip to the sintering plant where it was dumped wet with other sintering-plant ore.

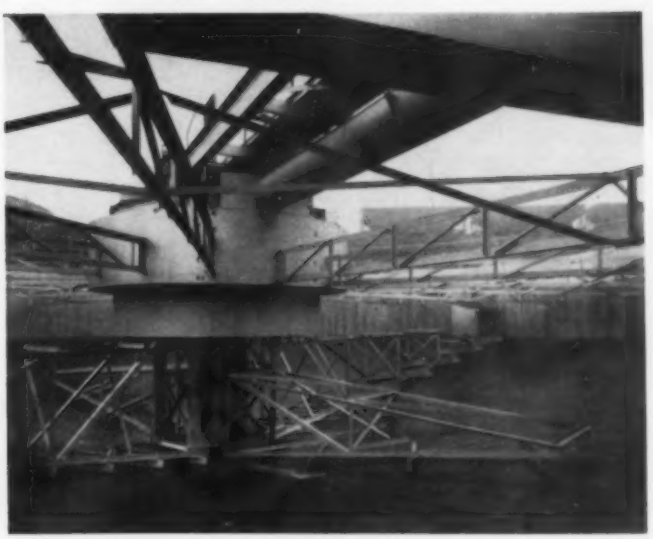
The completely new plant, designed by Dravo Corp. in cooperation with Jones & Laughlin's Engineering Department, consists of two Walker process "Clariflow" thickeners, sludge pumping facilities, vacuum filter plant, and dry cake handling facilities. The plant utilizes the existing gravity flow system from the washers at the blast furnace, which eliminates the need of a booster pumping station for handling the dirty water.

It was found possible to build one of the two thickeners with a new sewer system at the north end of the lagoon and thus maintain a large area of the lagoon for flue dust precipitation during construction. Once the first thickener was completed, the entire flow was diverted to this unit, the lagoon was eliminated and the second thickener was constructed in this area.

The heart of the plant is the two 105-ft diameter Walker process "Clariflow" thickeners, Figure 1, each of which is designed to handle a flow of 16,000 gpm. They are among the first of the new improved type thickeners utilizing the latest design in water clarification as well as sludge thickening. Their unique features are primarily in clarification design, which accentuates efficient hydraulic

Figure 1 — Jones & Laughlin blast furnace dust recovery plant has two 105-ft diam thickeners. Each unit is designed for a maximum flow of 16,000 gpm. Concentric overflow weirs uniformly work the entire settling area of the thickener. Sludge ejection building and filter house are in background.

Figure 2 — Sludge raking arms scrape the settled flue dust to the center of the thickener. Flue dust contains approximately 45 per cent (dry basis) iron, making it a valuable product for use in the blast furnaces after filtering and sintering.



control of the tank influent and overflow.

One important feature of the Clariflow thickener is the intake arrangement: The influent enters an annular ring, Figure 2, around the large center well from which it flows to the center well with a pronounced rotational movement produced by introducing it through multiple tangential diffusion ports. This diffusion energy causes a circular motion in the large center well which displaces downward and enters the floor region of the tank. Such a radially flowing density current, with equal acting vectors of flow displacement, gives balance and lateral distribution in the tank. This denser mass, leaving the bottom of the center well with a circular motion fans out along the floor of the tank as a density current.

In turn, clarified water, which is free of settleable solids, is displaced above this region and rises vertically upward, where a multiple balanced overflow weir system is arranged uniformly to work the entire surface area of the clarification zone. The velocity of approach to the weirs is held to a low level which prevents reaching back and inducing tendencies to draw previously settled solids up over the weir system. Velocity is so low and uniform that particles of previously settled precipitate introduced near the overflow weir will settle back counter current to the flow and will not overflow into the weirs.

Recirculation of previously precipitated solids by withdrawing them from the sludge hopper and pumping them back to the center well of the thickener materially increases the settling characteristics and clarification of the water. This is especially advantageous where the solids content to the thickener is relatively low (in the range of 100 gr per gal) such as is found at this plant.

The thickening section of the Walker Clariflow unit consists of an extremely rugged circular collector, Figure 2, driven by a limited torque motor through Tex Rope sheaves to a primary speed reducer and then through a chain drive to a 72 in. worm driven main gear. This drive is designed to handle very large tonnages of solids and to keep the mechanism moving under the heaviest loads. If the collector should encounter a load beyond its capacity—such as a power failure or other stoppage permitting the solids to settle compactly—a hydraulic lifting device is provided for raising the arms out of the mass. This same hydraulic system can be reversed for lowering the arms in increments to dig loose the packed material.

Figure 3 — The disc type filters receive slurry at about 50 per cent concentration and filter it to a cake of approximately 22.5 to 25 per cent moisture content. They are designed to handle 100 tons of flue dust a day.

The thickened slurrry (normally in the range of 50 per cent solids) is moved to the center sludge hopper which contains two slurry draw-off connections. Directly under the sludge hopper in the tunnel, which has been somewhat enlarged to make a pump room, are two Allen-Sherman-Hoff A-frame hydroseal pumps, for taking the thickened solids from the bottom of the thickener and pumping them to a receiver tank in the sludge ejector building near the thickeners and above ground level. The slurry pumps are so located in this tunnel as to make the sludge suction lines as short as possible. Normally, the Allen-Sherman-Hoff slurry pumps could deliver the thickened mud directly to the filter house, but since in this installation, it was necessary to locate the filter house at considerable distance from the thickener plant, it was found expedient to use a booster system for this purpose. The sludge discharge line is about 1500 ft long with a static head of 60 ft.

The Freyn ejector booster system consists of a receiving tank, where the discharge from the Allen-Sherman-Hoff slurry pumps is received, two air ejector tanks, necessary control valves, and air compressors. In operation, slurry from the receiving tank first feeds into one ejector tank until the tank is full. The flow is then automatically cut off and 100-psi air pressure introduced into the tank. This ejects the sludge to a receiver tank in the filter building. At the same time, through a three-way valve, slurry flow is automatically diverted to the second receiver tank where the process is repeated. This gives the advantage of extremely high velocity flow at high pressure when passing through the slurry line, thus eliminating tendencies for the long lines to plug. During one and one-half years of operation, these lines have never plugged under this procedure.

Slurry from the Freyn system is received in a tank in the top of the filter building, which in turn feeds the Eimco vacuum disc type filters, Figure 3, by gravity flow. The filters are five-disc units, 11 ft in diameter, with a capacity of approximately 100 tons of cake per 8-hour turn. The dry cake is discharged from the filters through a chute to a Continental Gin belt conveyor, which delivers it to a hopper adjacent to the sintering plant.

Two Fuller vacuum pumps, are installed to produce the required vacuum for the filters. Each pump has a capacity of 1690 cfm at 20 in. of vacuum referred to 30-in. barometer. These units operate at a speed of 635 rpm and are driven by 75-hp motors.

Included in the equipment at the filter house is a De Laval two-stage centrifugal pump utilized as a source for high pressure clean water service. This pump, used for cleaning the equipment, is also capable of supplying high pressure water for flushing any lines which might become clogged. There is a second duplicate pump unit in the ejector building which can be used for flushing sludge lines in the pump house or sludge ejection building if they should become clogged from any cause.

The plant not only improves the collection and handling of flue dust, and improves the clarity of the overflow to the river, but it also reclaims a large area of valuable land because the two thickener units require considerably less space than the old lagoon. The complete design, furnishing of equipment and installation work was performed by the Construction Department of Dravo Machinery Division.

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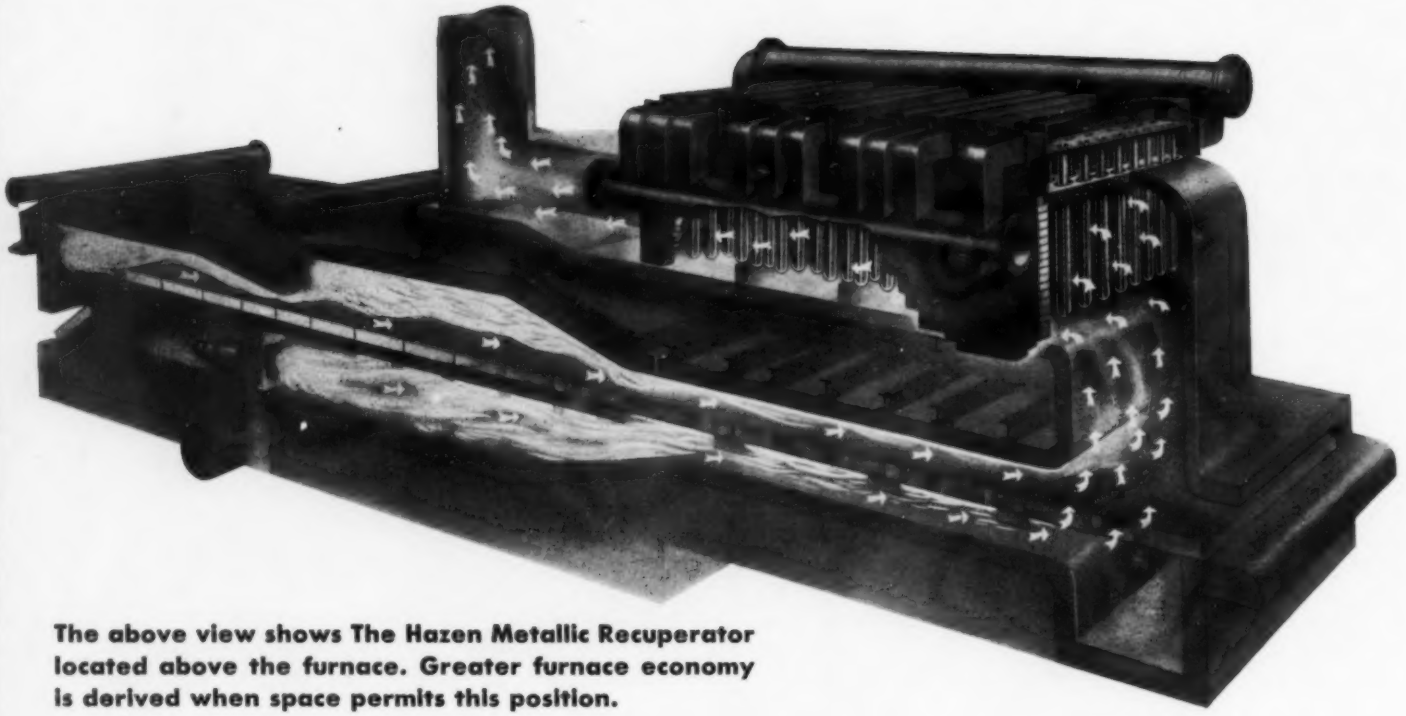
The HAZEN *Metallic*
FURNACE RECUPERATOR . .



The above view shows The Hazen Metallic Recuperator located above the furnace. Greater furnace economy is derived when space permits this position.

Features of This Application:

- This application takes advantage of the natural upward flow of flue gases.
- Less stack draft is required.
- Greater percentage of flue gases reach recuperator.
- Increased preheat . . . due to availability of a larger percentage of flue gases at higher temperatures.
- Economies in initial cost . . . by reducing the required amount of excavating and furnace foundation.

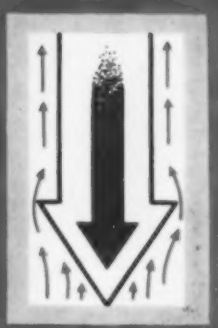
For Better Flow of Flue Gases from the Furnace to the Recuperator

. . . a logical change to

What Comes Naturally

IN THE FLOW OF FLUE GASES FROM THE FURNACE TO THE RECUPERATOR

The elevated position of recuperator, in above illustration, shows small amount of space required for recuperator as compared to total available space above the furnace.



CONVENTIONAL APPLICATIONS
RESIST
THE NATURAL UPWARD FLOW OF GASES

IMPROVED APPLICATIONS
ASSIST
THE NATURAL UPWARD FLOW OF GASES

- **Further economy . . . by reducing the length of flue ordinarily required from furnace to stack.**
- **Greater accessibility for ease of cleaning.**
- **Walkways may be provided around the recuperator for convenience of inspection and cleaning.**
- **Recuperator, flue and stack may be supported from steel work independent of the furnace bindings.**
- **Recuperator may be applied above an existing furnace with a minimum loss in outage time.**

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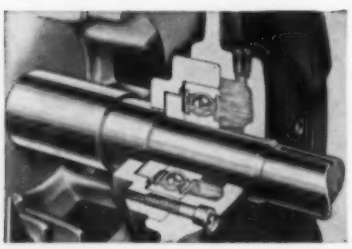

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PROGRESS REPORT ON CARBON BLAST FURNACES

By T. J. WILDE and V. J. NOLAN
National Carbon Co.
New York, N. Y.

. . . . paper presented at Eastern States Blast Furnace and Coke Oven Association meeting held on February 13, 1953, Pittsburgh, Pa. . . . .

▲ THIS report is a brief resume of the service record of National Carbon blast furnace linings, recent trends in use and design, and a detailed discussion of the current approach toward improved service. Much has been written and discussed about carbon linings installed during the period from 1945, when the first all-carbon hearth installation took place in this country, up through 1949. It was toward the end of 1949 that some operators, who had been installing carbon hearths, adopted, either officially or unofficially, a policy of "wait and see." And rightly so, since at that time there was no complete campaign record of a carbon hearth which had been in service under the conditions as they exist in the United States.

At the present time there are 102 blast furnaces in the United States equipped with carbon in one form or another. The smallest amount of carbon used may be in that area around the iron notch, in which case the carbon may extend six or seven feet to the right or left of the center line of the iron notch and may extend down as deep as the bottom of the hearth coolers and up to the top of the hearth jacket. The largest amount of carbon used, of course, is in that group of furnaces where the entire horizontal hearth and side walls extending up to the tuyeres is filled with carbon.

By the end of 1953 the total of 102 furnaces equipped with carbon should increase to approximately 119. Orders on file for carbon linings to be installed this year should very easily reach this figure.

Of the total number equipped with carbon, there are 27 furnaces of diameters 26 to 28 feet. There are 42 furnaces equipped with carbon in diameters from 20 to 25 feet 6 inches. The remainder of the furnaces are in diameters smaller than 20 feet.

One lining has exceeded the 2,500,000 ton mark, 12 linings from 2,000,000 to 2,500,000 tons, 19 linings between 1,500,000 and 2,000,000 tons, and 13 linings with tonnages between 1,000,000 and 1,500,000 tons. All of these linings have given remarkably trouble-free service. There have been but three tap hole failures on National Carbon hearth linings with a total of 21 days lost to these difficulties. These occurred within a short period in 1948 and 1949. No similar incidents have occurred in recent years.

The steel industry has "waited" and it has "seen." The general use of carbon as a blast furnace lining material is again in favor. There were five installations in 1950, seven in 1951, and ten in 1952. Three have already been made in 1953, and at the present writing there are 20 proposed for installation during the next 12 to 18 months. For comparative purposes, the peak year was 1948 with 23 installations of the double wall and horizontal hearth construction, and ten of other types of construction.

It may be interesting to note that prior to 1949 we installed 43 carbon linings of the double wall construction with all-carbon iron notches. Of this total number, 36 carbon iron notches are still running, and seven of the 43 were blown out for inspection purposes.

During the last seven years, a total of 32 inspections and careful studies of carbon linings in blast furnaces have been made. These have been in furnaces with tonnages ranging from a few hundred thousand tons up to as much as 2,250,000 tons. It is based on this actual experience and inspection of conditions that some changes in design of linings is founded.

As furnaces have come off the line for lack of demand, stack reline, etc., the hearth side walls and iron notch area have been available for study. In practically every instance there was no salamander removal to permit a thorough analysis of the conditions of the horizontal hearth. In every case, the hearth wall has been in excellent condition, showing little, if any, wear on the inside face from being in service. Even with these outstanding results in hearth walls of the original design of two courses of large carbon blocks backed up with about 3 in. of tarred coke breeze between this carbon wall and the cooling staves, there are several recent trends toward a variation of side wall construction. Since heat losses and wall temperatures are not quite as high in actual service as originally calculated, the necessity of the coke breeze backing is now somewhat questionable. From this experience, thinking has reversed itself from insulating the carbon wall to altering the design to increase thermal conductance through the carbon side wall by placing carbon directly against the cooling staves. Because of the relatively higher thermal conductivity of carbon material, this creates a chilling effect on the inside face generally believed to solidify furnace products against the hot face, creating a buffer against mechanical wear, and secondly, where iron penetration may occur in the joints between blocks, it will be frozen more readily.

Since it is most practical to gain this direct contact of carbon against the irregular face of the cooling staves with small shapes such as standard blast furnace brick sizes, a wall de-

sign currently in favor today is the use of the carbon brick shapes laid tight against the cooling, with a single large block course on the inside. This use of large block on the inner face cannot readily be discarded, since the outstanding lack of wear on carbon of this material and design has been displayed so prominently.

Another design of carbon side walls today is a solid wall made of carbon brick shapes laid against the cooling staves according to standard masonry practice. Three of the early carbon hearth installations in this country were of this design. Inspection of two of these recently indicated this carbon wall to be worn very little after these many years of service.

Apparently the use of all carbon in the side wall is the important thing; the double block design, the combination of brick and blocks, and the all carbon brick can now each be recommended as giving good service, each one having met the requirements of a blast furnace hearth wall refractory. The record of carbon hearth linings since January of 1950, including those installed as well as the 20 currently proposed, shows that 42 per cent of these linings have been of the double course large block design, 28 per cent combination blocks and brick shapes and 30 per cent solid carbon brick.

The relatively few spot checks of carbon bottoms through core drillings, etc., began to indicate some loss of carbon in the hearth area. This prompted another view to be taken of the economies of a carbon lining in the early part of 1950. An improved design was worked out using machined vertical faces of large carbon blocks so that these joints could be dowel pinned or locked in with longitudinal keys. Since the additional cost of this improved design is a very small part of the overall cost of the lining, such locked-in constructions have been used in many cases since 1950.

Thickness of the carbon bottom apparently also plays an important part on retaining the carbon to prevent salamander, the purpose for which it is originally intended. Extensive work done in the National Carbon research laboratories to determine heat distribution through a carbon bottom and how it is affected by increased thickness has now indicated the original 45 in. as providing insufficient mass for carrying the heat outward toward the cooling staves to arrive at a satisfactory interface temperature between the carbon bottom and the ceramic beneath.

Mechanical strength of the lining material must be considered. A large mass of material is being handled regularly and the design used should be sufficiently strong to cope with the mechanical problems as well as heat, corrosion and wear.

It has now been determined that a minimum of seven feet of thickness in a carbon hearth should be maintained to arrive at satisfactory temperatures for dimensional stability. The trend is toward increased bottom thickness in the use of carbon hearths as indicated by the following record since 1950:

45 in. — 57 per cent
57 in. — 24 per cent
85½ in. — 19 per cent

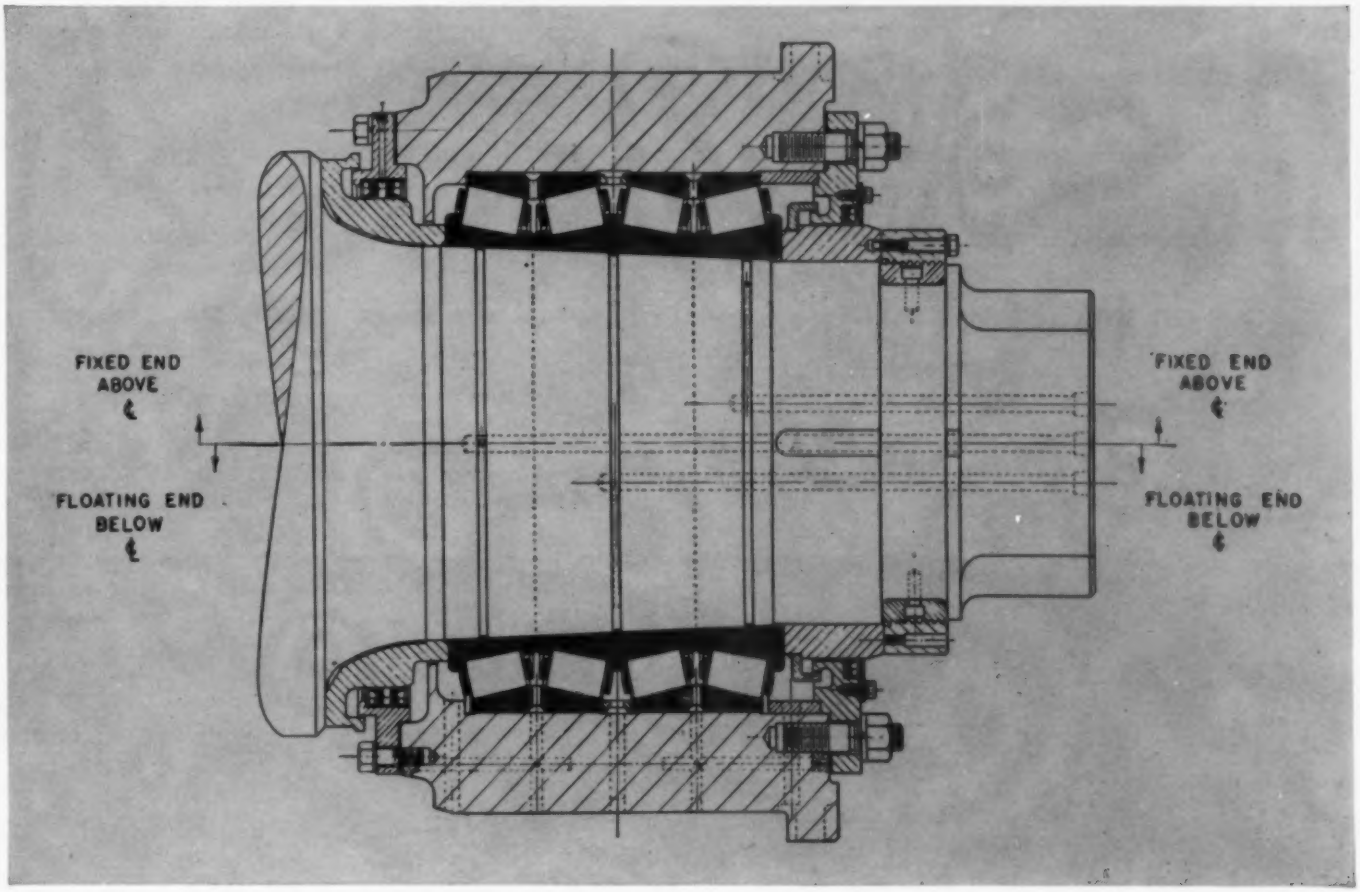
This is now approaching Central European practice of carrying carbon to a much greater depth.

The height of carbon in the side walls is steadily increasing. The three National Carbon linings installed in 1948 and 1949 which went up through the tuyere section to the bosh bend line are all successfully operating. An occasion to inspect one of these after two years of service indicated practically no evidence of wear on the hot face which is often thought likely to occur. Much interest in carbon bosh and inwall lining is currently shown. The advantages of carbon in these higher areas is to permit a change in lines of the furnace through the use of a thinner lining to increase capacity in an existing stack. Also, the lack of chemical attack and adherence and fusion on carbon with blast furnace material provides a smoother flow of stock downward, the lack of build-up eliminating restrictions with the ability to maintain a constant maximum production. The elimination of internal cooling with its initial and maintenance expense has also been considered in applying a carbon lining in the bosh and inwall.

The iron notch in carbon hearth linings originally was made of firebrick installed in a small window provided in the carbon hearth wall. This was soon displaced by the use of all carbon with large blocks making up the tap hole. Both designs have given long trouble-free service, and both designs have had a few failures. Inspections indicate that the inside face of the hearth wall surrounding the tap hole is subject to some wear, going into the wall thickness anywhere from 6 to 15 in., and from this depth at the hole tapering out along the face of the hearth wall in a saucer shape, the diameter of this worn area along the wall being from 4 to 6 ft. Under most conditions, this penetration apparently goes just so far into the hearth wall and no more. Furnaces with 500,000 tons, 1,500,000 tons or even 2,250,000 tons have had about the same amount of wear. This wear has been retarded through design improvements, such as the use of small carbon shapes to get immediate contact with the cooling staves around the tap hole, and an increased wall thickness of 9 to 12 in. in the area immediately surrounding the iron notch. This provides better cooling and a larger mass to conduct the excessive heat away from the tap hole during the cast. It is interesting to note that in many cases in the last two years, while the furnace has been down for a stack reline, the tap hole area of a carbon hearth lining has been completely rebuilt very effectively. This is usually done with carbon brick shapes for an area of about 6 feet on either side of the centerline of the iron notch, starting on the original solid carbon hearth, which side walls in every case are still in place and very close to the original thickness installed.

Over a considerable length of time, the National Carbon Co. has done laboratory work on the development of a water-free tap hole mix. A carbonaceous tap hole mix binder to be used with regular clays or mixes currently in use now appears to be the conclusion of this work. This is intended to displace the water only, with the operation continuing with the same high quality clay or mix proven best. Obviously, this work can be carried just so far in a laboratory, the final stages of development must take place under actual field conditions in the tap hole of a blast furnace. Two such field runs have been made to date, with the third now in progress. In all three runs, very effective stops were made, uniform length of hole was maintained, and the material was considered to be workable in the field as far as mixing and extruding through the mud gun are concerned.

New tapered bore TIMKEN® bearing has interference fit—yet is easy to remove



THE world's first 4-row tapered roller bearing with a tapered bore—recently announced by The Timken Roller Bearing Company—is now in service at a midwestern steel mill. The new bearing provides maximum bearing capacity for high-speed roll necks, has an interference fit, yet can be quickly removed from the roll neck by expanding its cones hydraulically. Excessive scuffing and neck wear are eliminated.

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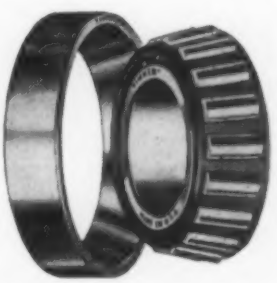

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ULTRASONIC WAVES USED FOR INDUSTRIAL CLEANING

▲ THE Detrex Corp. of Detroit, Mich., manufacturer of industrial cleaning equipment and chemicals, has announced the development of an advanced, practical method of metal cleaning through the use of ultrasonic waves. The new method, known as the Detrex Soniclean Process, features a man-made element for directing sound energy — a development which opens the door to far-reaching advances in a wide variety of industrial fields.

Use of the new transducer element unquestionably takes ultrasonic cleaning out of the laboratory dream stage and makes it a production reality. By employing this new element in place of the quartz crystals previously used in ultrasonic experiments, the limitations caused by the size and properties of quartz have been overcome.

The use of ultrasonics for cleaning is not a new or revolutionary idea. Such experiments have been conducted for years.

The transducer element, jointly engineered by Detrex and the Brush Electronic Co., is a curved piece of ceramic resembling a six-inch-long pipe, cut in half along the longitudinal axis. The ceramic pieces, which can be connected in series and arranged as desired, are designed to offer focusing and flexibility properties never before found in equipment of this type.

In the process, electrical energy is transmitted to the ceramic transducer, converted into sound energy, and projected through a solvent at a frequency of 430,000 cycles per second. The solvent currently being used in the Soniclean process is tri-

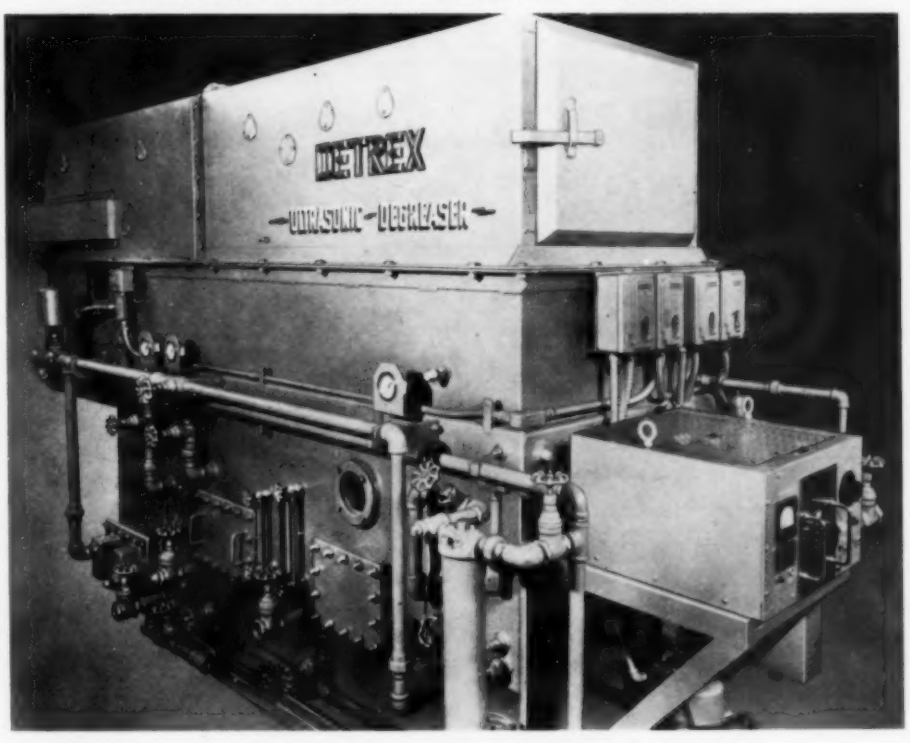

Figure 1 — New, fully-conveyorized, ultrasonic degreaser. Final cleansing of parts by the use of ultrasonic waves is incorporated in the regular degreasing cycle. The equipment shown here is more than six feet high and 12 feet long. Note high frequency generator at right.

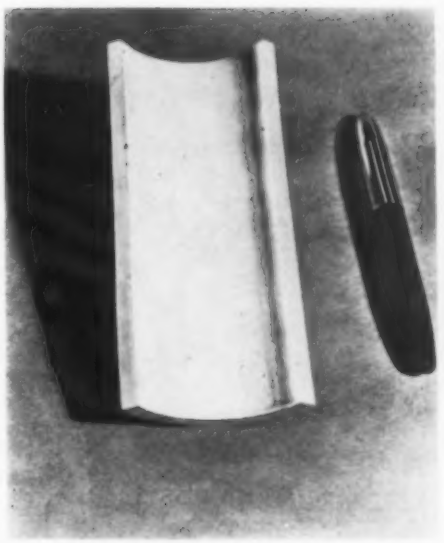

Figure 2 — Shown here is the man-made, ceramic transducer — heart of the new ultrasonic cleaning process. Its size, focal properties and flexibility are considered far superior to natural quartz crystals used in previous ultrasonic cleaning processes. The ceramic elements can be connected in multiple units.

Figure 3 — Foreign matter adhering to the surface of a jet engine blade is shown here as it is almost literally "exploded" away by ultrasonic waves. In this case, the substance is an iron oxide paste which is used to coat the blades to help detect possible flaws and which is extremely difficult to remove by ordinary methods.

chlorethylene; however, the process is not limited entirely to this material. Because a potential of only 40 volts is required to operate the ceramic transducers, they can be safely immersed directly in the solvent. This eliminates the complicated sealed containers that are required with other transducer materials and high voltages.

Material to be cleaned is placed in the solvent, either manually or by conveyor, directly in the path of greatest focal intensity of the ultrasonic waves. In this area an extreme turbulence is created, resulting in a deep and penetrating cleaning action that removes, almost instantaneously, all dirt, grease, chips and microscopic particles of soil from even the most intricately designed and close-fitting parts.

Because of the design of the ceramic transducer, the sound waves converge to a straight line as long as the transducer itself. The focal area in other transducers is confined to a single point. This restriction limited ultrasonic cleaning almost to a one-at-a-time rate, which is impractical for the demands of modern industry.

The high frequency hypersonic generator used in the Soniclean process is completely protected by numerous safety and overload devices and provides easily adjustable tuning drawers that offer absolute frequency control. The unit operates on low voltage current.

First commercial equipment employing the Soniclean process has been purchased from Detrex by the Electric Shaver Division of Remington Rand, Inc., Bridgeport, Conn. Fully conveyorized, it is the largest commercial unit ever built for ultrasonic cleaning.

In cases where exceptional cleaning quality is required or where parts have fine openings, crevices and other hard-to-clean forms, the Detrex Soniclean process is fast and economical. In regular degreasing equipment, the Soniclean process will be added to the cycle for the maximum refinement in cleaning a part to meet the most rigid standards. There are virtually no limitations placed on the type and kind of work which may be successfully cleaned by the process.

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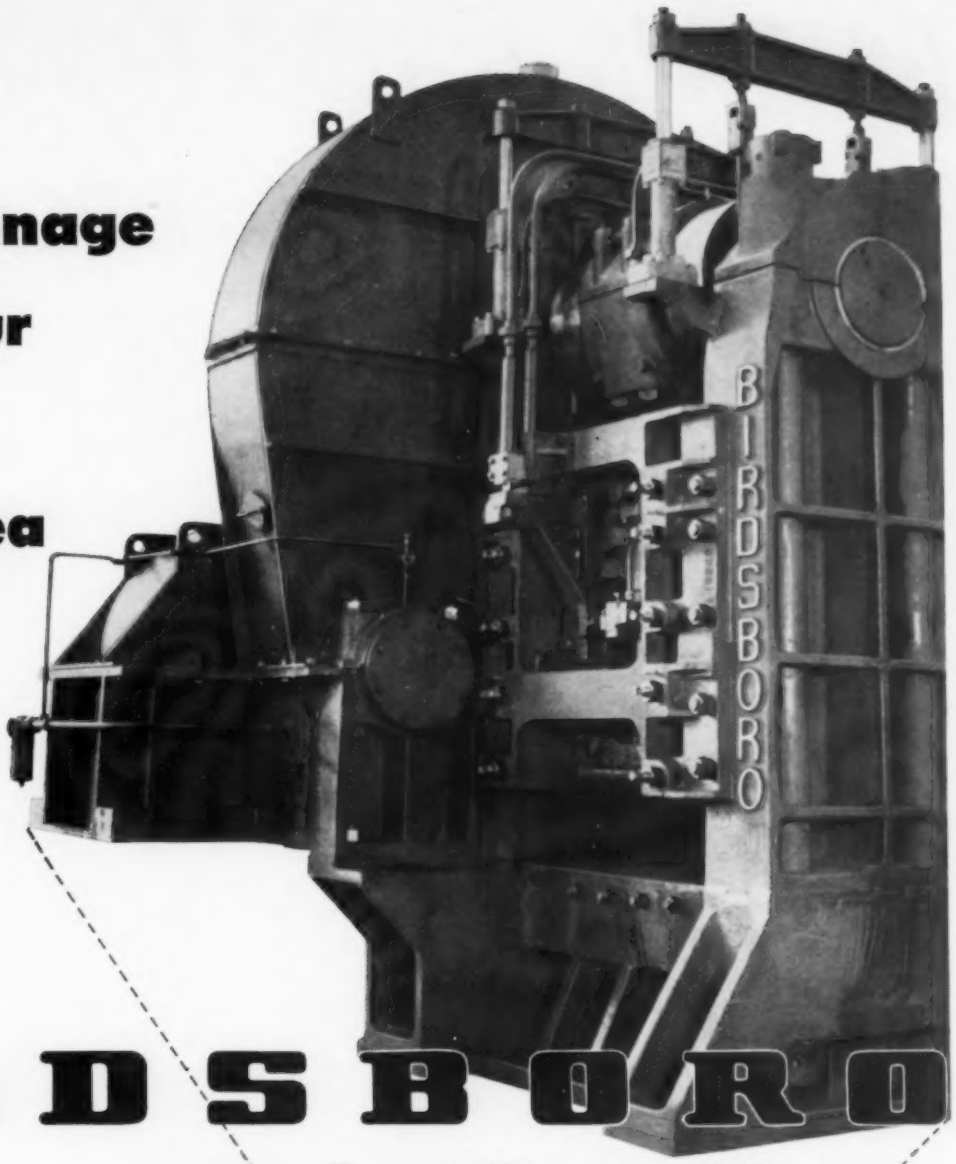

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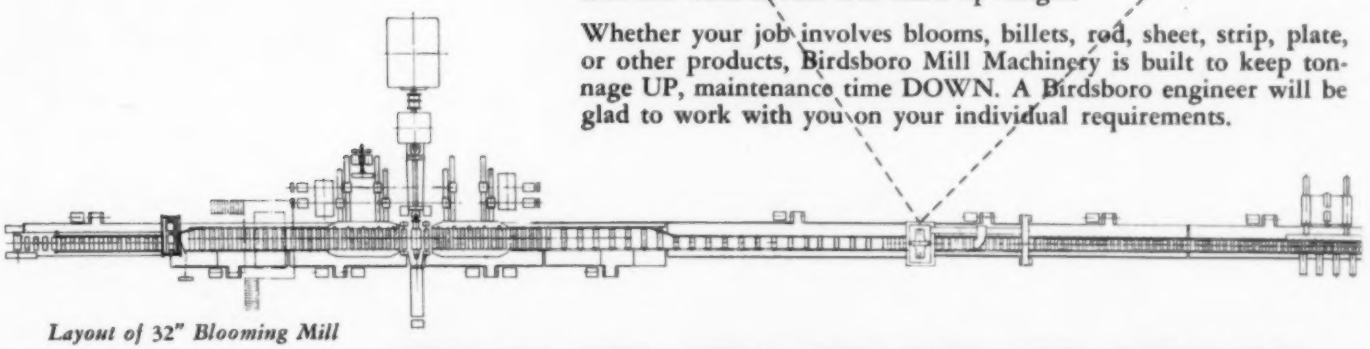

Layout of 32" Blooming Mill

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BALDWIN BUILDS LARGE SPLIT DIE FORGING PRESS

▲ NEARING completion in the Southwark shops of Baldwin-Lima-Hamilton Corp., is the largest split die forging press in the world. Upon erection in the plant of Cameron Iron Works, Inc., Houston, Tex., the press will stand as high as a six-story building and the supporting foundation will contain a pit 40 ft deep.

The new pull-down type press, with a capacity of 11,000 tons, will be equipped with a piercing ram at the top and knock-out ram at the bottom, and two horizontal side rams for clamping vertically split dies, or for piercing when using horizontally split dies. Main pull-down capacity of the press will be supplied by two 51-in. diameter, 60-in. stroke, single-acting cylinders of 5500 tons each. Two 18½-in. cylinders, with a net stripping capacity of 300 tons, will be used as pullbacks. With a bolster area of 10 × 10 ft, the press will have a maximum vertical opening of 12 ft and maximum horizontal clearance between side-ram faces of 15½ ft.

The two horizontal side-ram cylinders, each made from a single steel forging, have a capacity of 6000 tons of 8000 psi. Each ram is 48 in. in diameter with a 24-in. stroke, and two pullback cylinders on each side have a total capacity of 500 tons.

Top piercing capacity of 3000 tons is furnished by a single 38-in. diameter, 24-in. stroke cylinder. Two pullback cylinders will supply 300 tons net stripping capacity. The piercing ram extension contains a motor driven spindle threaded on its lower end to engage the piercing tool. A double-acting bottom piercing cylinder will have 750-ton piercing and 280 tons pullback capacity.

All of the platens, base, etc., for this mammoth machine were fabricated from steel plate, up to 6½ in. thick. Before welding, it was necessary to preheat the plates with gas torches. After each part was fabricated complete with bracing plates, column husks, etc., it was placed in Baldwin's heat treating furnace for stress relieving. Some 64 miles of welding wire went into the job.

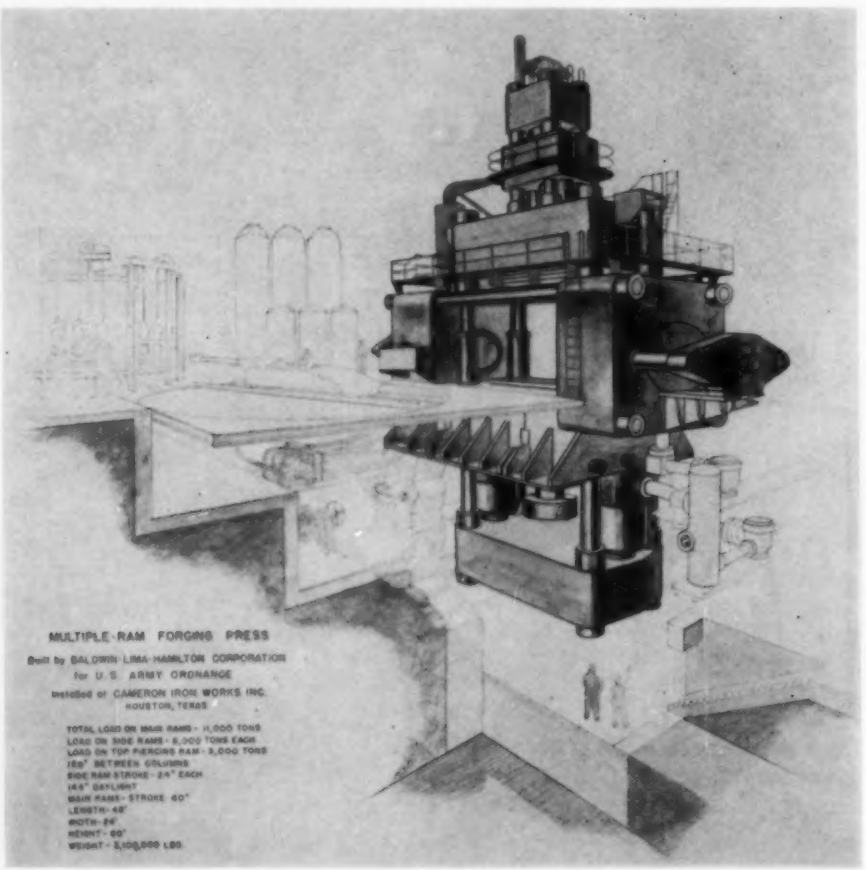
Each side platen weighs 200,000 lb and the base, complete with cheek sections containing the down stops, weighs 660,000 lb. Construction of the base in three sections was necessary to keep within permissible shipping dimensions because only three railroad cars capable of carrying such loads are in existence.

The hydraulic actuating system will include three low-pressure (125 to 150-psi) vessels with a useful capacity of 1500 gal; three high-pressure bottles (4950 to 5500 psi); three 5500-psi, 250-hp triplex pumps, the necessary air compressors, and pressure intensifiers to build hydraulic pressure up to 8000 psi.

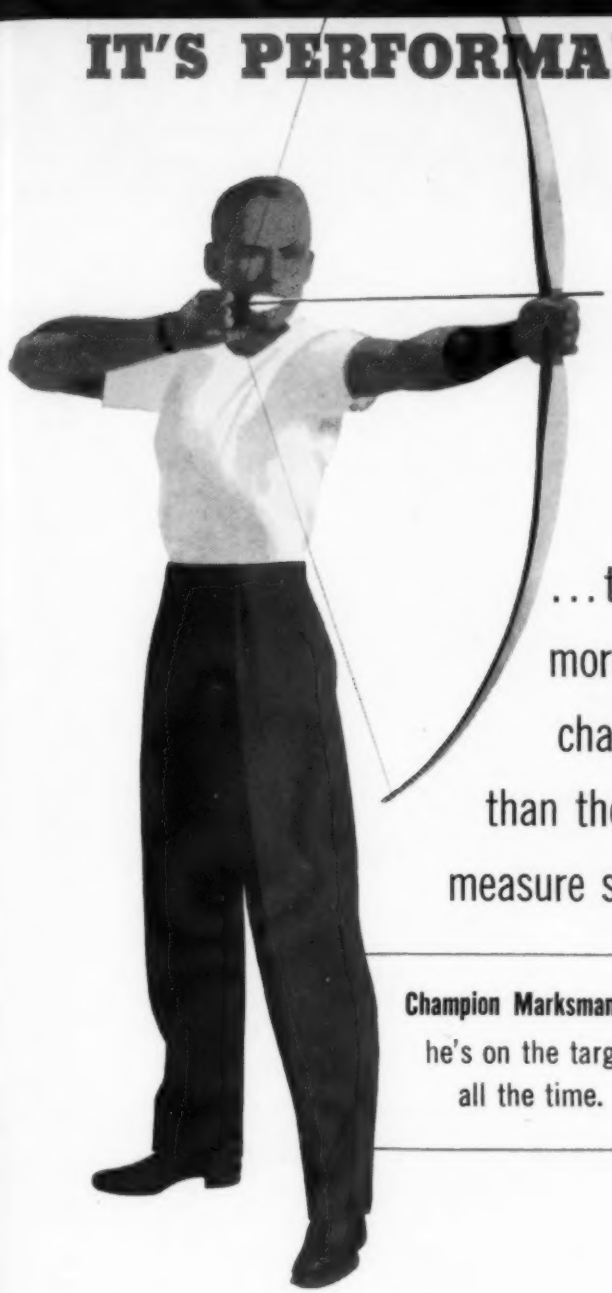
The pump house control panel will be provided with a graphic panel board on which will be a flow-diagram likeness of all pumps, bottles, rams, etc. A glance at the board will tell the engineer how each unit is functioning during press operation.

When the new press goes into production to increase the facilities for split die forging work at Cameron Iron works, it will be another step in this process which the company pioneered many years ago by installing the first press for such a method. It was the first approach to the broad field of intricate shapes and forms that, here-to-fore, had been limited to steel castings. Forgings produced in closed, split dies need practically no draft and there is little or no flashing to be removed from the rough part.

Figure 1 — Artist's conception of the completed press with cut-away view to show foundation construction and lower details of press design.



IT'S PERFORMANCE THAT COUNTS



. . . there's more to a champion than the tape measure shows!

Champion Marksman . . . he's on the target all the time.

Average Marksman . . . he may measure the same, but he misses when conditions are tough.

HARDTEM DIE BLOCKS

perform like "champions" in your production line!

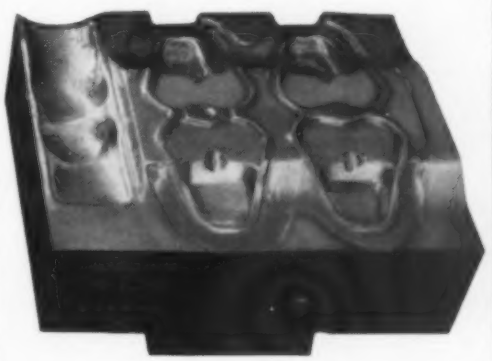
Heppenstall Hardtem Die Blocks perform like "champions" because they possess those extras that result in superior quality. Their patented steel analysis resists softening and heat checking in service. Records from plants using Hardtem Die Blocks prove the following benefits for production:

★ **Long life of dies** ★ **Holding of true dimensions**

★ **Less down time** ★ **Longer production runs**

★ **Lower overall die cost**

It will pay you to try Hardtem Die Blocks. Call Heppenstall Company, Pittsburgh 1, Pa. Sales Offices in principal cities.



Heppenstall

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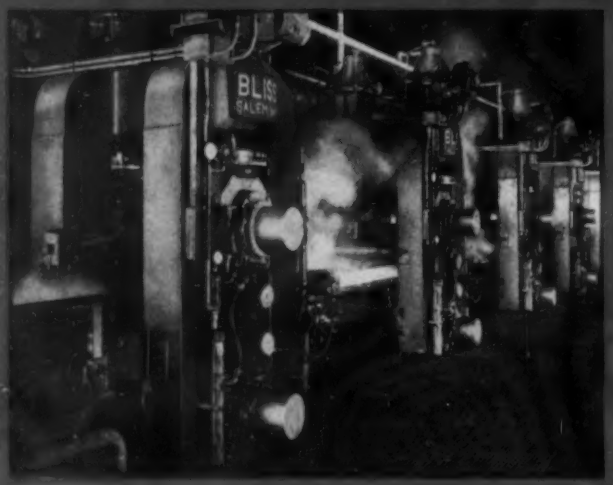
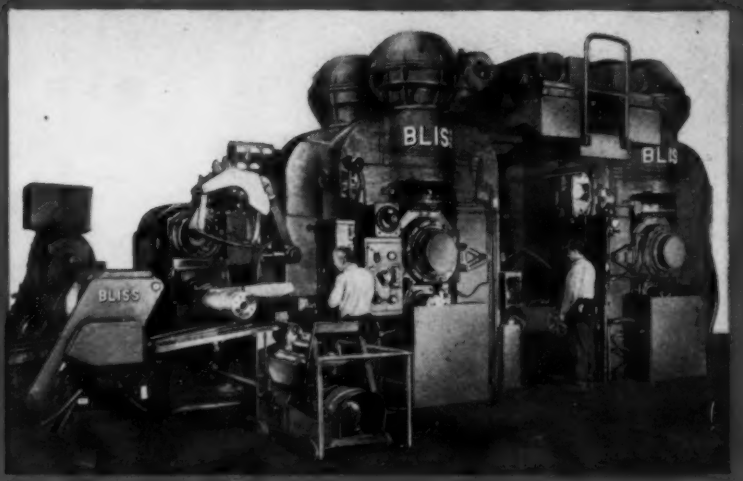
Whatever your metal-rolling job...

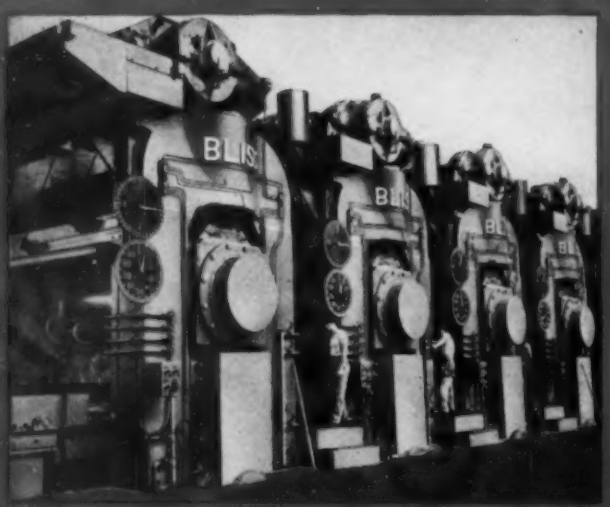
Hot..... Cold..... STEEL..... BRASS..... ALUMINUM.....



HOT-ROLLING STAINLESS · A Bliss 24″, five-stand hot finishing train handles all the hot-rolling of stainless and "specialty" steels at Superior Steel Corporation. Since the thin stainless is slit into narrow strips, extreme accuracy and flatness are vital.



BRASS TANDEM · Brass and copper breakdown is the job of this Bliss four-high, two-stand tandem strip mill at the Springdale, Conn., plant of Stamford Rolling Mills Company. Bliss coiler, at far left, coils flat bars. Tension reel winds lighter-gage coils. A coil mandrel and elevator permit quick handling of heavy-gage coils.



HOT-ROLLING ALUMINUM · This five-stand, four-high 80″ tandem mill hot-rolls aluminum sheet strip. Engineered and supplied complete by Bliss for a leading aluminum producer, this mill includes all necessary special auxiliaries such as roll brushers, guides and up coilers.

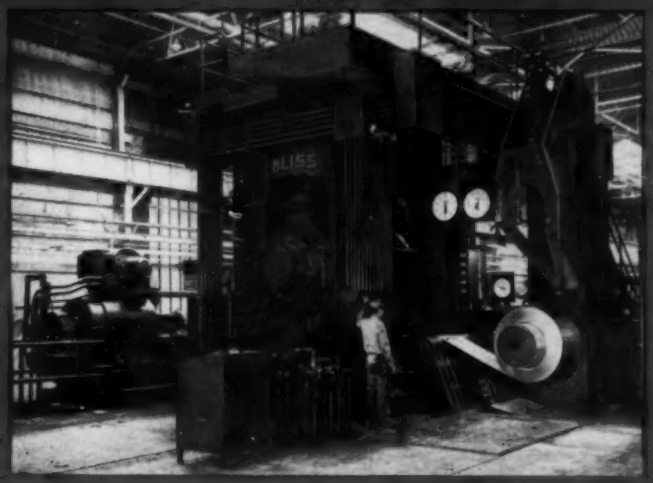
UP-CUT SHEAR LINE · Coiled steel is converted into uniformly flat sheet blanks at speeds up to 240 fpm by this shear line, designed by Bliss for Alan Wood Steel Company's 30″ hot mill. The Bliss continuous shear line performs nine operations—from feeding to piling. It is suited for use in steel, brass and copper mills or fabricating plants.

Remember:

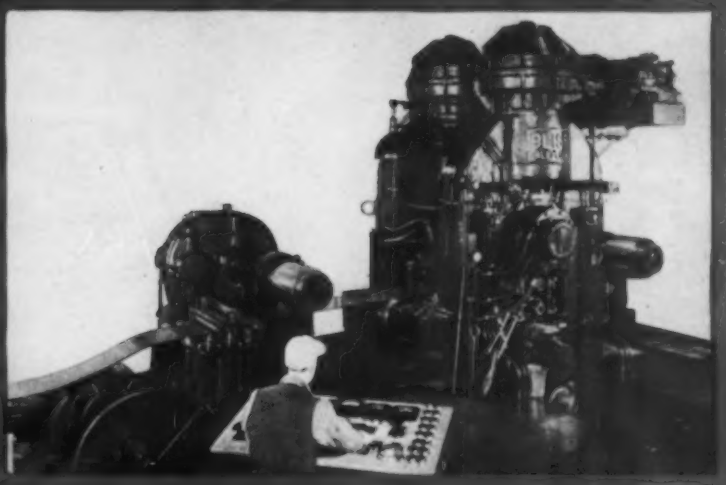
for Presses, ROLLING MILLS...

there's a BLISS mill to do it

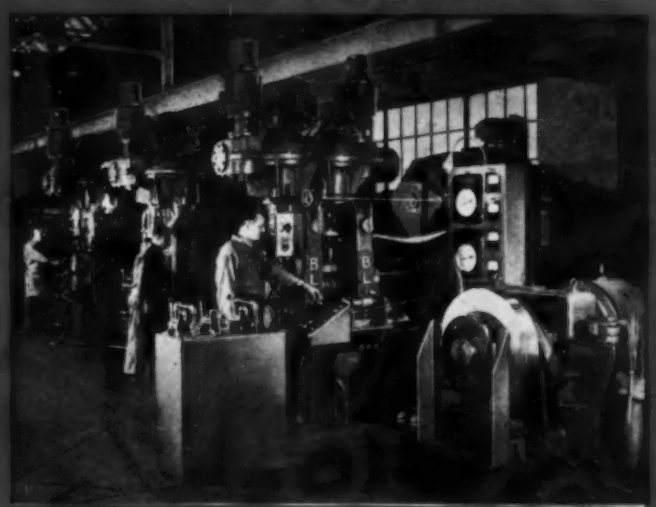
.....Breakdown.....Rundown.....Finishing.....



STEEL TEMPER PASS · Bliss four-high temper-pass mill, installed at the South's leading steel plant, rolled a record tonnage of steel in eight hours. Here, it tempers 20-gage steel at 3500 fpm, handles 30- to 13-gage, 20″ to 48″ wide. It handles sheet stock coils up to 72″ in diameter



FOUR-HIGH REVERSING · This four-high reversing cold reduction mill, specially designed by Bliss, proved to be the answer to the Greer Steel Company's "varied" requirements—a rugged, versatile mill to maintain exacting standards for quality of finish and accuracy of gage on short runs and quick changeovers.



COLD-ROLLING STAINLESS · The steel plant for whom Bliss built this three-stand, two-high mill reports a 50% average reduction in a single pass; accurate cold-rolling and finishing of stainless and special alloys within .0005″ overall; 'round-the-clock operation at speeds up to 600 fpm.

For many, many years, the world's major metal-producing plants have specified Bliss rolling mills. Built for precision work at maximum speeds, Bliss mills take the abuse of continuous, high-speed operation with least possible maintenance.

Bliss builds a complete line of rolling mills and accessories for hot or cold rolling of ferrous or nonferrous metals. Whatever your metal-rolling problem, you can look to Bliss for the right answer. Take the first step by writing for the Bliss 52-page brochure, including an extensive range of rolling mill machinery and many useful pages of engineering tables.

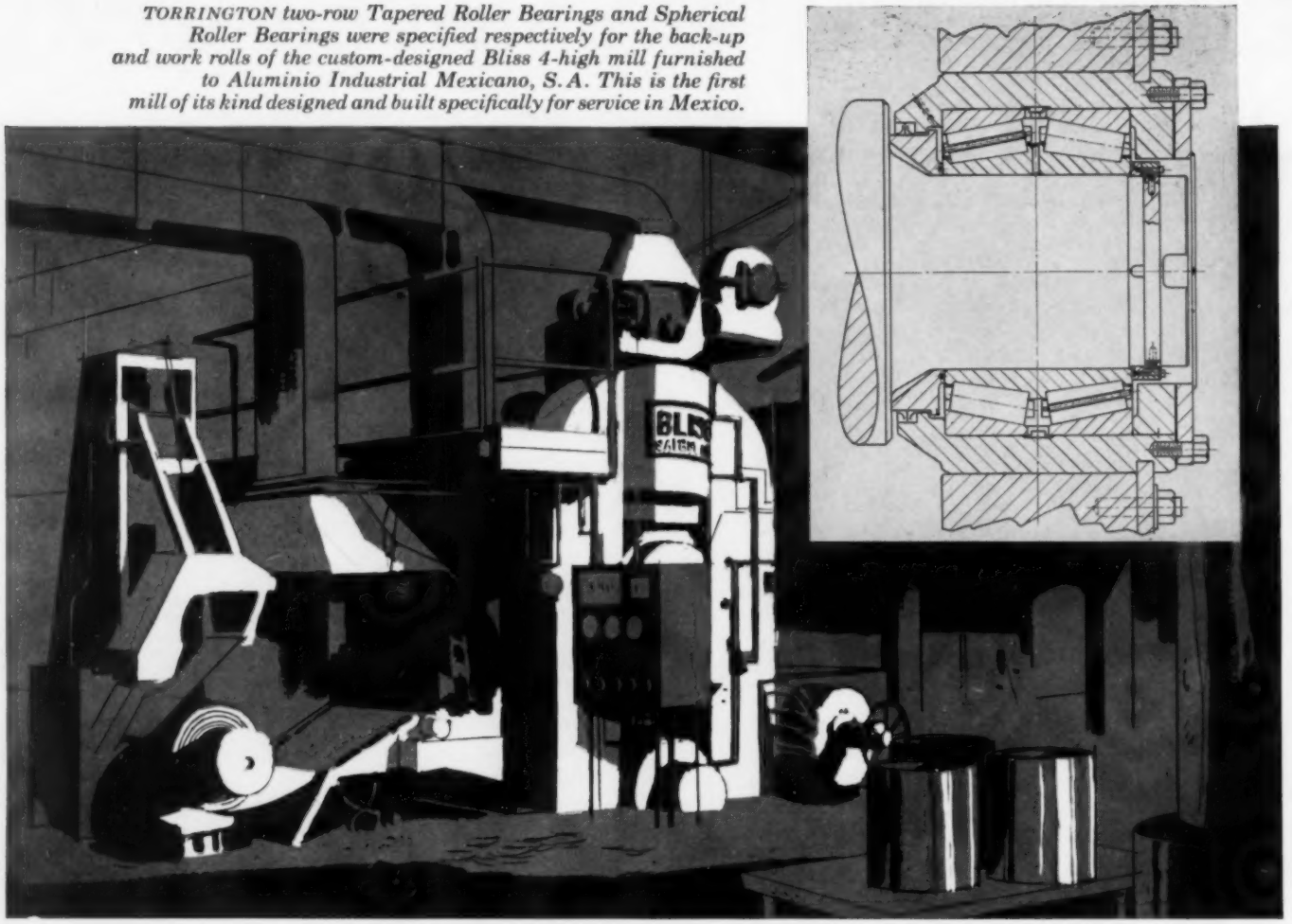
E. W BLISS COMPANY
General Office: Canton, Ohio
ROLLING MILL DIVISION: SALEM, OHIO

Branch offices in Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven, New York, Philadelphia, Rochester, Toledo; and Toronto, Canada. West Coast Representatives: Moore Machinery Co., Los Angeles and San Francisco; Star Machinery Co., Seattle. Other dealers in United States cities and throughout the world.

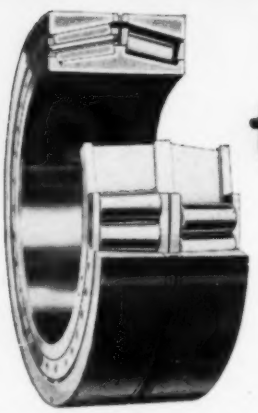
and Special Machinery..... IT'S BLISS

TORRINGTON BEARINGS AT WORK

TORRINGTON two-row Tapered Roller Bearings and Spherical Roller Bearings were specified respectively for the back-up and work rolls of the custom-designed Bliss 4-high mill furnished to Aluminio Industrial Mexicano, S.A. This is the first mill of its kind designed and built specifically for service in Mexico.



Rolling higher tonnage records!



TORRINGTON two-row Tapered Roller Bearings are speeding production on many of today's toughest back-up roll applications.

Made from the finest of bearing-quality, case hardening steels, they handle maximum radial and thrust loads with ease. Precision ground, the quality of their surface finishes is uniformly high. And they are available with either pin-type or cast-bronze, land-riding cages.

These advantages, plus controlled lubrication, mean free-rolling service, long life and minimum maintenance attention under virtually any operating conditions.

TORRINGTON two-row Tapered Roller Bearings—like the four-row Tapered Roller Bearings and Spherical Roller Bearings—offer one of the surest, most economical ways to roll higher tonnage records *consistently*.

And tonnage records are the test of any roll-neck bearing. So next time specify TORRINGTON!

THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.

TORRINGTON BEARINGS

Spherical Roller • Needle • Tapered Roller • Straight Roller • Ball • Needle Rollers

Visit the Tycol Exhibit!
American Society of Lubrication Engineers
Hotel Statler, Boston, Mass.
April 13-15

...with TYCOL lubricants on hand!

Take metal fabrication, for example. There's a Tycol lubricant for any application you can name: For instance, what about tough machining jobs? . . . Tycol Afton cutting oil keeps cutting edges cool . . . lengthens tool life between grinds. Machine tool hydraulic systems? . . . Tycol Aturbrio oxidation and rust inhibited oils keep them running smoothly. Open gears of metal forming equipment? . . . Tycol Amaclac lubricants cling like cat hair on a serge suit. You always get top performance with Tycol lubricants. Why? . . . Because each Tycol grease and oil is manufactured from high quality base stocks and *tailored* for a specific application. Get the full story of the entire Tycol line from your local Tide Water Associated office today!

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This is *PRECISION*

A-C Crane Hoist Control

15 Tons of Steel . . . handled as though it weighed a pound. The picture at the right tells the story. A walnut and wrist watch were placed side by side. The operator lowered the 15-ton, full-hook load. The walnut was cracked. Then the load was raised without the least settling action. The watch was left untouched.

That's Precision . . . precision that is attained on all cranes equipped with the new Westinghouse Load-O-Matic Crane Control. In this particular test, the load was lowered with the master switch set at the first point lower. No jogging, inching or retardation was necessary—lowering rate was smooth and steady.

The Load-O-Matic hoists and lowers *all* loads—the empty hook, light or maximum loads—at stabilized speeds. Loads can be brought to a standstill or suspended by action of the motor only.

VERNIER CONTROL PROVIDES FLEXIBILITY

Additional flexibility of operation is available with the auxiliary Vernier control. This control component is especially useful for high-accuracy spotting. For example—with full load on the hook and the master switch on the first lowering point, operation of the Vernier provides control from approximately 7% of full speed to standstill. Operator can actually float the load into the desired spot.

ASK FOR DESCRIPTIVE BOOKLET B-5417

This booklet describes all the operating characteristics and features of the Load-O-Matic a-c crane hoist control. Ask your Westinghouse representative for your free copy, or write direct to: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-27015-A

YOU CAN BE SURE...IF IT'S

Westinghouse

This simple test of the Westinghouse Load-O-Matic was conducted at a Materials Handling Conference and witnessed by more than 100 engineers. The full load of 15 tons was lowered at an almost imperceptible speed till it cracked the walnut. The watch was not damaged. Then the load was raised without the least settling action.

STEEL MILL GAS WASHERS CLEANED WITHOUT SHUT-DOWN

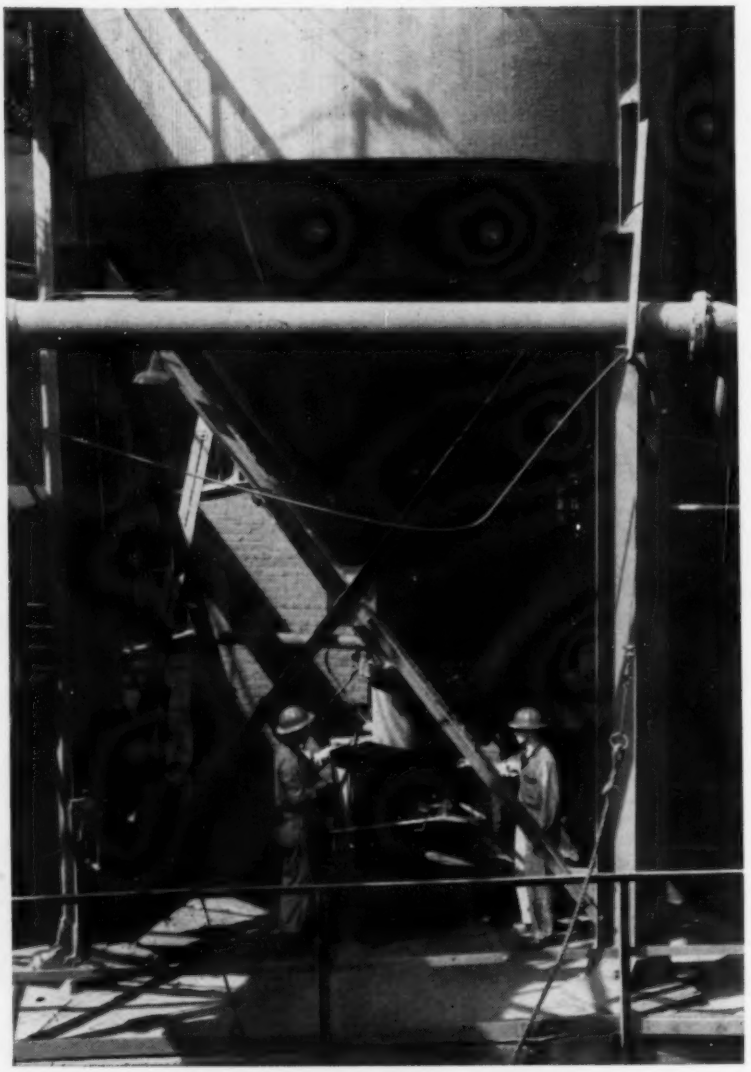
Cleaning with Chemicals by Dowell Service Saves Costly Dismantling and Downtime

Here's a comparative case history that points out the advantages of Dowell Service over mechanical cleaning methods.

The blast furnace to be serviced had three gas washers which needed cleaning. One of these was cleaned mechanically. The other two were cleaned with chemicals by Dowell Service.

The mechanical cleaning took three days time and required 768 man hours. The remaining two washers were cleaned simultaneously by Dowell Service *in just four hours* . . . without interrupting washing operations or reducing blast furnace wind.

With specially-designed Dowell pump trucks and control equipment, experienced Dowell engineers can give you fast cleaning service. Many pieces of equipment can be cleaned while in operation.



Free Bulletin on Chemical Cleaning for Steel Mill Equipment

For your convenience, we have prepared an informative bulletin that tells you about the chemical cleaning of many different kinds of steel mill equipment by Dowell Service. For your free copy, write today to Dept. D29, Tulsa, Okla.

DOWELL SERVICE

Over 90 Offices to Serve You with Maintenance Cleaning for:

Boilers • Condensers • Heat Exchangers • Gas Mains
Stoves • Furnace Cooling Systems • Piping Systems • Gas Washers • Process Towers • Ammonia Scrubbers • Precipitators

Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED
Tulsa 1, Oklahoma

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

Date-line Diary...

March 2

▲ Based on reports from companies having 93 per cent capacity for the steel industry, the operating rate is scheduled at 99.5 per cent of capacity for the week beginning March 2. This is equivalent to 2,244,000 tons of steel ingots and castings compared with actual production of 2,240,000 one week ago.

▲ R. T. Elstad, president of Oliver Iron Mining Co., a subsidiary of United States Steel Corp. announced plans for building an iron ore treatment plant at an estimated cost of $60,000,000 at Two Harbors, Minn.

March 3

▲ Under the Reconstruction Finance Corp. plan recommended to President Eisenhower and Congress, the 28 synthetic rubber plants operated by RFC for the government should be sold to private industry on a negotiated basis instead of by sealed competitive bidding.

▲ Shipping officials predict record iron ore shipments for 1953 due to the early start of the Great Lakes shipping season this year. The first freighter docked in Buffalo on March 2 from Detroit, which is the earliest the season has ever begun.

March 4

▲ The Bureau of Statistics reported Canada's January steel ingot output reached a new monthly high of 339,215 net tons, or an increase of 34,000 tons over January 1952.

March 5

▲ The Commerce Department reported January manufacturers sales amounted to $24,000,000,000, or $1,700,000,000 higher than one year ago.

▲ Alfred Krupp, Germany's industrial magnate, was ordered by Western Allies to sell his coal, steel and iron holdings and in return he will have sole control over the remainder of an estimated $95,000,000 worth of family property.

March 6

▲ Hot and cold strip mill employees numbering 3000 from Bethlehem's Lackawanna plant walked off the job in dispute over working conditions.

▲ The price of zinc dropped ¼¢ to 11¢ a lb in East St. Louis.

▲ Granite City Steel reports net sales for 1952 of $74,587,639, and net income after taxes of $4,985,954, which is equivalent to $3.17 per common share.

March 7

▲ According to the Commerce Department, personal income in January was at an annual rate of $280,500,000,000, or 6 per cent higher than January 1952.

▲ Workers from United States Steel Corp.'s Robena Mine returned to work after a three day strike following an order from John L. Lewis.

March 9

▲ Based on reports of companies having 93 per cent of capacity for the steel industry, the operating rate for the week beginning March 9 is scheduled at 99.9 per cent of capacity. This is equivalent to 2,252,000 tons of ingots and castings compared with 2,262,000 tons one week ago.

▲ According to the AISI, steelmaking plants in the United States now number 143, an increase of 15 in the last fourteen years.

March 10

▲ Labor unions were upheld in two cases involving charges in violation of provisions in the Taft-Hartley Act limiting "feather-bedding."

▲ General freight rate increases were awarded Canadian railroads averaging 7 per cent.

▲ The Commerce Department reported dividend payments in January and February, 1953 by United States corporations rose to $729,000,000, an increase of 6 per cent over a year ago during the same period.

March 11

▲ According to the American Railway Car Institute, February deliveries of new domestic freight cars totaled 7780 compared with 7358 in February 1952. Orders for February totaled 2284. Backlog of cars on order as of March 1 was 71,883.

▲ United States Steel Corp. increased stainless steel prices 3 per cent on some grades and 2 per cent on others effective February 28.

▲ The Commerce Department reported business inventories at the end of January were valued at $74,000,000,000, or $550,000,000 higher than one year ago.

▲ The price of lead was increased ½¢ to 13½¢ a lb in New York.

March 12

▲ Production of primary aluminum during January 1953 totaled 179,790,195 lb, compared with 166,817,187 lb in December 1952. January shipments of sheet and plate totaled 109,989,095 lb, a gain of 7,000,000 lb over December 1952.

▲ David J. McDonald, president of the CIO steelworkers, announced plans for organizing drives in the new iron ore mines in Labrador and Quebec, the metal mines in the West, and possibly in bauxite and iron ore mines in South America.

March 13

▲ The government removed price controls on several items, but ceilings remain on steel mill products, machine tools, and several industrial metals.

March 15

▲ United Engineering and Foundry Co. announced net sales for 1952 of $85,097,554. Net income after taxes totaled $3,772,906, or $1.51 per common share.

▲ According to the F. W. Dodge Corp., construction figures for the 37 states east of the Rockies in the first two months of 1953 totaled $2,097,178,000, or a 17 per cent increase for the same two months of 1952.

March 16

▲ Based on companies having 93 per cent of capacity for the steel industry, the operating rate for the week beginning March 16 is scheduled at 100.1 per cent of capacity. This is equivalent to 2,256,000 tons of ingots and castings compared with 2,284,000 tons one week ago.

▲ The steel industry predicts capacity operations for the first nine months of 1953 as the demand for steel continues particularly by automobile makers to meet their increased production quotas.

▲ Under the Defense Materials System, the only materials which will be controlled after June 30 will be for atomic energy needs and direct defense.

March 17

▲ United States Steel Corp. has notified customers that current prices on tin mill products will continue in effect until September 30.

▲ At a special meeting, stockholders of Harrisburg

Steel Corp. voted to approve acquisition of Heckett Engineering, Inc., Butler, Pa. and its subsidiary Heckett International, Inc.

▲ Allis-Chalmers Manufacturing Co. in its annual report announced net sales for 1952 of $513,641,331 compared with $457,060,766 in 1951. Profit for 1952 was $24,457,855, and this is equivalent to $7.98 per common share.

March 18

▲ The OPS ended price curbs on all products which remained under ceilings, six weeks prior to the date when they were to be decontrolled.

▲ The second largest producer of sulphur, Freeport Sulphur Co., boosted prices $3.50 to $4.00 a ton as soon as controls were lifted.

▲ United States Steel Corp. announced net income for 1952 of $143,687,746 after taxes compared with $184,359,787 in 1951. This is equivalent to $4.54 per common share. Products and services sold in 1952 totaled $3,137,397,336 compared with $3,524,121,-226 in 1951.

March 19

▲ At its annual stockholders meeting scheduled in May, Republic Steel Corp. will request an increase in authorized common stock from 10,000,000 to 20,000,000 shares.

▲ An increase of 4¢ an hr retroactive to December 1, 1952 was awarded to railroad workers covering 19 rail unions.

▲ In an effort to keep their mines running during the present slump, small producers reduced soft coal prices 20¢ a ton, to electric utilities on the east coast to become effective April 1.

▲ The Cleveland-Cliffs Iron Co. have raised iron ore prices for the second quarter. The new price is $9.70 which is a net hike of 28¢ per gross ton to the consumer.

▲ The maximum price of scrap has been set at $36 per ton for the six nations composing the European Coal and Steel Pool.

▲ The Interstate Commerce Commission has been requested by railroad spokesmen to make the 15 per cent temporary rate increase which was authorized in April 1951 permanent. This rate is due to expire February 28, 1954, unless action is taken on it.

March 20

▲ The word manganese has been redefined in amended Order M-80 by the National Production Authority, Department of Commerce to "ferro manganese, manganese metal, silico-manganese, silicospiegel, spiegeleisen, and all other compositions used as sources of manganese in the manufacture of any alloy products." This was done due to a reduction of manganese content in manganese ore available to the United States.

March 21

▲ Exporters and importers will no longer require Dominion approval for shipments of aluminum, tungsten, tin, copper, lead and zinc across the United States-Canadian border since Canada has suspended all export and import controls.

March 23

▲ Walter Reuther, president of the United Auto Workers, warned that his union would not negotiate long-term contracts unless his demands for increases in pay rates and pensions are met by automobile manufacturers.

▲ The Commerce Department stated that economic and military aid by the United States to foreign nations totaled $5,600,000,000 in 1952, or 10 per cent above 1951.

▲ Based on reports of companies having 93 per cent capacity for the steel industry, the operating rate for the week beginning March 23 is scheduled at 100.2 per cent of capacity. This is equivalent to 2,259,000 tons of steel ingots and castings compared with 2,288,000 net tons one week ago.

March 24

▲ On June 30, 1954 the Reconstruction Finance Corp. will cease to exist, and gradual liquidation will be started at once.

▲ According to a survey by the Securities and Exchange Commission and the Commerce Department, United States business firms plan to spend a record $27,000,000,000 on new plants and equipment in 1953.

▲ In January world production of tin was 17,300 tons, which is the highest recorded since World War II.

March 25

▲ Phelps Dodge Corp. increased its price for refined copper 1½¢ to 30¢ a lb.

▲ According to the AISC, February shipments of fabricated structural steel totaled 237,499 tons, and shipments for the first two months of 1953 totaled 477,391 tons. Bookings for February totaled 182,184 tons, and the backlog of work as of February 28 stands at 2,128,389 tons.

March 26

▲ National Steel Corp. announced net earnings for 1952 of $37,559,477, and this is equivalent to $5.10 per common share. Total sales were $548,625,817.

March 27

▲ The Crane Co. will try to obtain a Federal loan to build a $26,000,000 titanium plant, which would enable the company to become the nation's largest producer of the metal. In return the government would have first call on the output of the product.

March 28

▲ Makers of machine tools booked $85,000,000 worth of new orders in February, or 12 per cent higher than in January.

March 30

▲ Based on reports from companies having 93 per cent capacity for the steel industry, the operating rate for the week beginning March 30 is scheduled at 100.8 per cent of capacity. This is equivalent to 2,273,000 tons of steel ingots, and castings compared with the weekly record high of 2,324,000 tons one week ago.

▲ The expansion goal for blast furnace capacity has been set at 87,000,000 tons instead of the 85,000,000 tons originally planned, in order to assure sufficient pig iron for production of steel ingots to meet mobilization needs.

▲ The Association of General Contractors foresee total construction volume of $44,000,000,000 in 1953.

▲ Colorado Fuel & Iron Corp.'s Claymont, Del. plant has purchased 60,000 tons of basic pig iron from Australia. The first 20,000 ton shipment is scheduled for delivery within four or five months.

March 31

▲ Producers of copper are aiming toward a uniform price of 30¢ a lb.

▲ When 4500 employees of Union Railroad Co., a subsidiary of United States Steel Corp. went out on strike at midnight March 31, four large plants of the corporation were shut down causing 30,000 employees to become idle.

▲ Republic Steel Corp. announced sales totaling $925,088,437 for 1952, and net income was $44,-274,053, which is equivalent to $7.21 per common share.

CALL Curry!

FOR STEEL PLANT EQUIPMENT

FOR SALE—Immediate Delivery!

REVERSING COLD REDUCTION MILL

Available for immediate delivery — at great savings in cost — this 2½" dia. and 20" dia. x 7½" face, 4 Hi Reversing Cold Reduction Steckel Mill illustrated right is a complete operating unit, with mechanical and electrical equipment including motor-generator set and spare parts. Call, write or wire today.

CALL CURRY on the following good, usable equipment:

2000 H.P., G.E. SLIP RING MILL TYPE MOTOR, 3/60/2300 v 237 RPM, complete with Liquid Slip Regulator and all controls necessary for mill type operation, including Filtered Air Cooling System.

75-TON MORGAN LADLE CRANE. WITH 25-TON AUXILIARY. 4-Girder Construction. Span 49'6". Motors & Controls for 230v. DC operation.

18"/21" 3-HIGH BAR MILL, complete with Pinion Stand, Gear Reduction Unit, 2500 H.P. Motor, Billet Heating Furnace, Tables and Electric Equipment.

80" HYDRAULIC STRETCHER LEVELLER, Capacity 80" wide x 200" long, complete with all Hydraulic Pumps, Controls, and Motor.

400 H.P. GEAR REDUCTION UNIT (WESTINGHOUSE), Single Reduction, Helical Gears, Ratio 6 to 1.

600 H. P. GEAR REDUCTION UNIT (FARREL-BIRMINGHAM), Ratio 2.95 to 1, Single Reduction, Rebuilt 1950.

CANTON ALLIGATOR SHEAR, Capacity 3" dia. rounds. 26" knives. Complete with 35 H.P. S.C. Motor.

50 H.P. CROCKER-WHEELER S. C. MILL TYPE MOTOR. Size EW. 230 V. 560 RPM.

D & K No. 2 ALLIGATOR SHEAR, 21" Knives, 7½ H.P. 3/60/220-440V Motor.

5 TON OVERHEAD ELECTRIC CRANE, 47' Span D.C. Cab Operated.

Write today for the Curry List of Available Steel Plant Equipment!

ALBERT Curry & CO., INC.

STEEL PLANT EQUIPMENT

Cable Address — Curmill Pittsburgh

940 OLIVER BUILDING • PHONE ATLANTIC 1-1370
PITTSBURGH 22, PA.

PITTSBURGH FOUNDRY.

JOSEPH M'CLURG respectfully informs his friends and the public, that his *AIR FOUNDRY* is now in complete operation, where he will execute all kinds of *CASTINGS* in the best manner, as also machinery of whatever description, cast to any given pattern.

He also continues to carry on

The Manufactory of Tobacco.

And has now on hand a Quantity of

PLUG AND PIG TAIL TOBACCO, SEGARS AND RAPPEE SNUFF,

equal if not superior in quality, to any manufactured in the state, and lower in price than it can be brought here.

HE HAS LIKEWISE ON HAND,

A handsome & general Assortment OF GOODS,

Suitable for the present and approaching seasons.

ALSO,

A Large and General Assortment of

NEW GENEVA

Window and Hollow Glass,

Of a superior quality, and at the Pittsburgh prices. Merchants descending the Ohio, and others, will find it to their interest to call on him.

February 12. 5t

Advertisement of 1805, placed by Joseph McClurg, founder of "Pittsburgh Foundry," first in Pittsburgh, and forerunner of Mack-Hemp. This ad appeared in the *Commonwealth*.

1803

Mack-Hemp's one hundred-fifty years

MACK-HEMP ROLLS

with the striped red wabblers

for all metal forming operations

There's a hundred and fifty years of *experience* and *know-how* in Mack-Hemp Rolls; experience learned in every segment of the metals industry, and know-how which has kept pace with the growing industries from the days of McClurg's *AIR FOUNDRY* to the present.

Although Mack-Hemp can no longer accommodate you with snuff and window glass, our line of M-H rolls with the striped red wabblers is modern and complete. We are always glad to discuss your rolling mill operations with you.

1953

of service to the metals industry

check this list against your roll requirements

The metallurgical properties of all M-H rolls are carefully controlled for maximum service

MACKINTOSH-HEMPHILL COMPANY

Makers of the Rolls with the Striped Red Wabblers

PITTSBURGH AND MIDLAND, PA.

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: rolls . . . steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . Mackintosh-Hemphill rotary straighteners . . . improved Johnston patented corrugated cinder pots and slag-handling equipment . . . shape straighteners . . . end-thrust bearings . . . shears . . . levellers

ROLL APPLICATIONS

for normal mill conditions:

Slabbing Mills . . . . . Midland Superalloy

Blooming Mills . . . . . M-H Technalloy

Structural Mills:
- Roughing . . . . . Midland Superalloy
- Intermediate . . . . . Midland Supermetal B
- Finishing . . . . . Midland Supermetal E

Merchant Mills:
- Tandem Roughing . . . . . Midland Superalloy
- First Roughing . . . . . Midland Supermetal B
- Intermediate . . . . . Midland Supermetal B
- Leaders . . . . . Midland Supermetal D
- Finishers . . . . . Nironite C

Continuous Bar & Billet Mills:
- Roughing Mill . . . . . Midland Superalloy
- Finishing Mill—Rough . . . . . Midland Supermetal B
- Finishing Mill—Finish . . . . . Nironite C

Rod Mills:
- Roughing . . . . . Nironite AX
- Intermediate . . . . . Nironite C
- Finishing . . . . . Nichillite No. 2

Billet Mills — 3-High . . . . . Midland Supermetal D

2-H Strip and Hoop Mills:
- Roughing . . . . . Nironite A
- Finishing . . . . . Nironite C

Sheet & Tin Mills:
- Roughing . . . . . Technalloy A
- Hot Rolls . . . . . Mo Technichill
- Water Mills . . . . . Nichillite No. 2
- Cold Rolls . . . . . Nichillite No. 4

2 and 3-High Plate Mills . . . . . Nironite F
- Floor Plate . . . . . Midland Supermetal B

Universal Mills . . . . . Nironite F

Three-High Breakdown Mills . . . . . Midland Supermetal A

Three-High Finishing Mills . . . . . Nironite F

Pipe Mills—Lap & Butt Weld, Seamless Electric Weld:
- Piercing . . . . . Machempite
- High Mill Pinch Rolls . . . . . Technikrome B (Adamite)
- High Mill . . . . . Technikrome B (Adamite)
- Reeler . . . . . Nironite A
- Sizing . . . . . Nironite A Special
- Reducing . . . . . Technikrome E (Adamite)
- Finishing . . . . . Techni-Spec. Chill
- Planishing . . . . . Techni-Spec. Chill
- Welding . . . . . Technikrome B (Adamite)
- Straightening . . . . . Techni-Spec. Chill
- Forming . . . . . Techni-Spec. Chill

Non-Ferrous Mills:
- Hot Break Down—2-H . . . . . Nichillite No. 2
- Cold Break Down—2-H . . . . . Midland Superalloy
- Cold Running Down—2-H . . . . . Nironite B
- Cold Finishing—2-H or 4-H . . . . . Nichillite No. 4
- Back-Up Rolls . . . . . Midland Special

Continuous 4-High Wide Strip Hot Mills:
- Back-Up Rolls . . . . . Midland Special
- Scale Breakers No. 1 . . . . . Midland Superalloy
- Roughing No. 1 Stand . . . . . Midland Superalloy
- Work Rolls—No. 2 Stand . . . . . Nironite A
- Work Rolls—No. 3 Stand . . . . . Nironite A
- Work Rolls—No. 4 Stand . . . . . Nironite A
- Scale Breaker No. 2 . . . . . Midland Superalloy
- Work Rolls No. 5 . . . . . Nironite F
- Work Rolls No. 6 . . . . . Nironite F
- Work Rolls No. 7 . . . . . Nironite F
- Work Rolls No. 8 . . . . . Nironite F
- Work Rolls No. 9 . . . . . Nironite F
- Work Rolls No. 10 . . . . . Nironite F or Nichillite #6
- Edging Rolls . . . . . Technikrome B (Adamite)

4-High Tandem Mills, Temper and Skin Pass Mills:
- Back-Up Rolls . . . . . Midland Special
- Work Rolls . . . . . Nironite F or Nichillite #6

Mackintosh-Hemphill manufactures several types of rolls for each of the applications referred to above. A conference with a Mack-Hemp roll engineer will assure you the most efficient and economical roll for your particular requirements.

DESIGNED AND BUILT EXPRESSLY FOR HEAVY INDUSTRY

DELTA-STAR'S NEW DISRUPTOR SWITCH

600 ampere Disruptor without fuses . . . for interrupting service only.

These new heavy duty metal-enclosed switches are designed for 600 volt A.C. or D.C. service . . . combining the functions of both disconnect and load interrupter. Rugged in construction they are designed for severe usage in steel mills and other heavy industries.

Available in current ratings of 400, 600, 1200, 2000 and 3000 amperes, the Delta-Star Disruptor is applicable for use in opening motor circuits; for main entrance or branch feeder control; as disconnects for transformers, capacitors, furnaces or ovens, and other similar applications.

With its arc disrupting chamber, the Disruptor offers consistant, safe, positive load interruption. Speed of operation is predetermined and beyond the control of the operator to assure proper operation. Tests have proved the ability of these switches to interrupt twice full rated capacity repeatedly.

Wherever conditions necessitate dependable heavy duty equipment, install Delta-Star's new Disruptor switch. It is by far the most substantial high capacity interrupting switch available.

600 ampere Disruptor . . . with "Amp-trap" fuses.

POSITIVE ARC EXTINCTION

Delta-Star's exclusive arc disrupting chamber of non-combustible material mounted on each pole quickly and positively extinguishes the arc. Contacts are protected against burning and pitting.

QUICK MAKE-BREAK MECHANISM

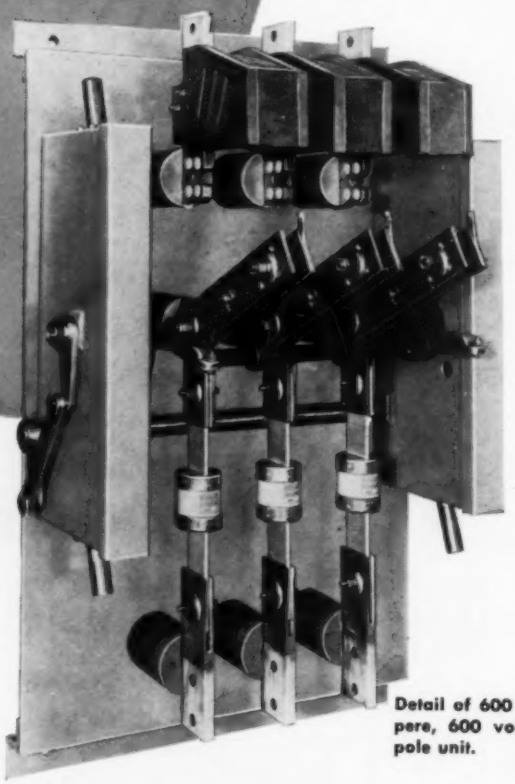
Multiple compression springs put the final act of opening or closing beyond control of the operator. One on each side of the unit, keep the blades in perfect alignment at all times.

HIGH PRESSURE CONTACTS

Self-cleaning, high pressure silver contacts maintain sufficient pressure to carry current efficiently and still permit easy operation.

HEAVY STEEL CABINETS

10 gauge steel cabinets are designed with liberal gutter space for incoming and outgoing conductors. Continuous welded seams and weather-tight gasketed doors exclude dust and corrosive particles. Doors are mechanically interlocked with the operating handle so they cannot be opened until the switch is in the "open" position. With the door open, the switch cannot be closed. All cabinets and operating handles have full provisions for padlocking.



Detail of 600 ampere, 600 volt 3-pole unit.

CONSULT THE FACTORY OR OUR NEAREST DISTRICT OFFICE FOR COMPLETE INFORMATION

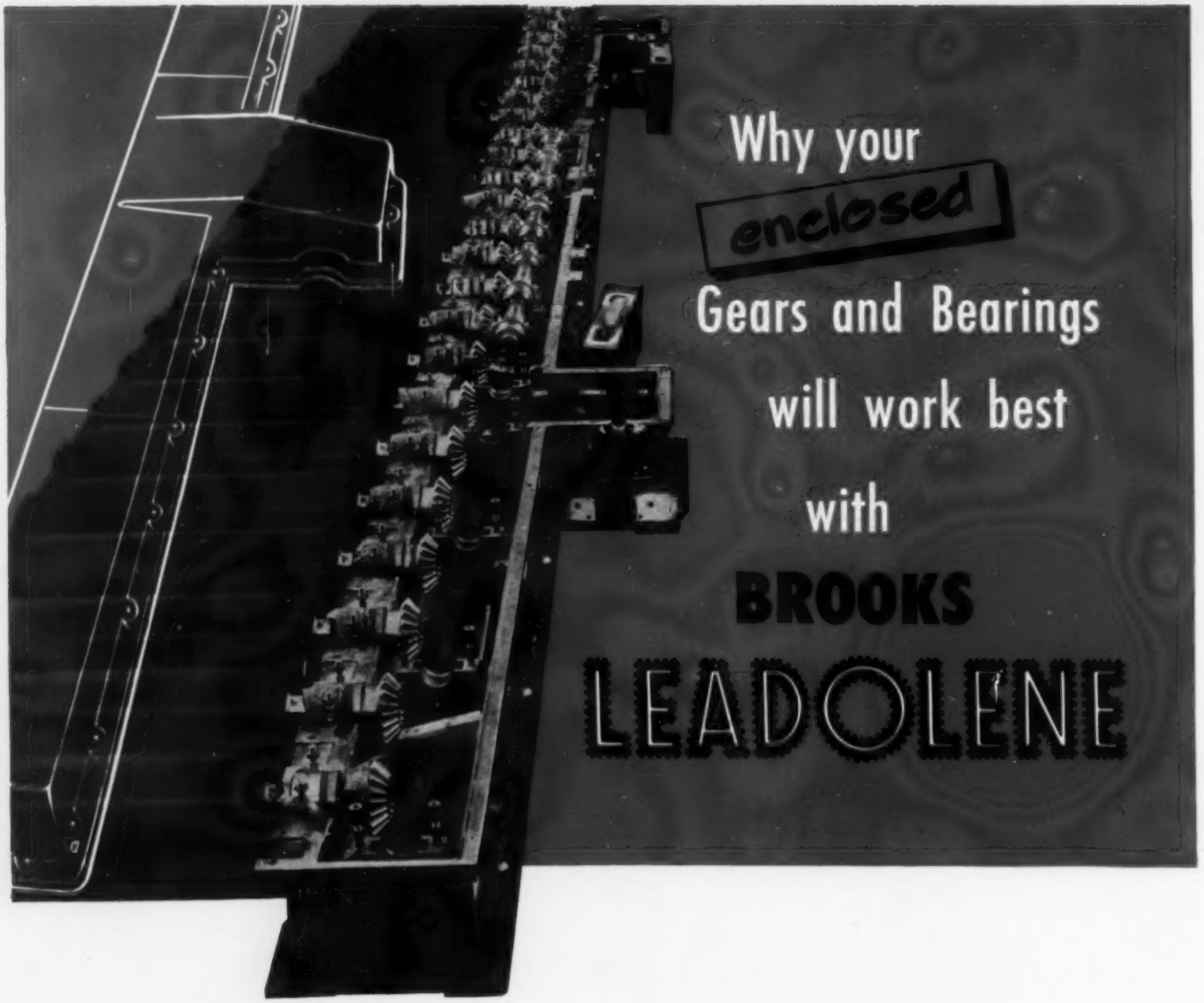
DELTA-STAR ELECTRIC DIVISION

H. K. PORTER COMPANY, INC.

2437 FULTON STREET, CHICAGO 12, ILLINOIS

DISTRICT OFFICES IN PRINCIPAL CITIES

DRAVO
DESIGNERS and BUILDERS
BRIDGES AND UNLOADERS • TOWER-TYPE UNLOADERS
WHIRLER CRANES • FLOATING CRANES
DRAVO RAIL CLAMPS • BARGE SHIFTERS
MODERNIZED TROLLEYS FOR EXISTING BRIDGES
This new rope-operated coal unloader was designed, built and installed by Dravo for a large power generating plant on the Monongahela River.
The unloader is equipped with a seven-and-one-half-ton bucket and has a free-digging capacity of 800 tons per hour for unloading coal from river barges.
Many power companies and industrial plants have called on Dravo Corporation for similar installations. Why not make use of Dravo's more than 60 years of practical experience when planning a material-handling project?
DRAVO
CORPORATION
NEVILLE ISLAND, PITTSBURGH 25, PENNSYLVANIA
AIR CONDITIONING • BOILER AND POWER PLANTS • CRANE CAB COOLERS • DOCKS • INDUSTRIAL FOUNDATIONS • OPEN STEEL FLOORING
PUMP HOUSES AND INTAKES • SPACE HEATERS • WATER AND WASTE TREATMENT PLANTS • TOWBOATS AND BARGES



Enclosed gears . . . with their close tolerances, high speeds, shock loads, and great bearing and tooth loads . . . operate best when protected by Brooks LEADOLENE. With its "Indestructible pH-ilm Strength," this lead-based lubricant is definite assurance against pitting, galling, finning of teeth and abnormal bearing wear. The lubricating efficiency of LEADOLENE is not affected by water.

The following case history indicates the kind of service you can expect from LEADOLENE: "*Although a good quality lubricant was used in a certain Cleveland plant's enclosed gear reduction units . . . the gears, bearings and shaft journals required replacement so frequently that the reductions were taken apart every four months. At that time they were cleaned, some replacements were made and new lubricant was added. When LEADOLENE No. 90 was adopted as the lubricant, the reductions were operated for over two years with no replacements and no serious wear.*"

For reduction gear sets . . . mill table gear drives . . . or any other enclosed gear application—you will profit by standardizing on Brooks LEADOLENE as your lubricant.

WRITE for the 20-page brochure, "The Brooks Oil Story". . . or for consultation by a Brooks Engineer.

With LEADOLENE you get these characteristics

pH-ilm Strength . . . 30,000 psi minimum.

Adhesiveness . . . Affinity for metal develops maximum adhesion providing permanent coating on gears.

Water Repellence . . . Effectiveness is not reduced by water.

Corrosion Prevention . . . Never acidic and will not etch or corrode.

Compounded Stability . . . Will not bleed or change physical condition within a greater temperature range.

Low Temperature Factors . . . Does not harden, crack or decrease in adhesion.

Abrasive Resistance . . . Repellent to adhesion of scale, metallics and other contamination.

THE BROOKS OIL CO.

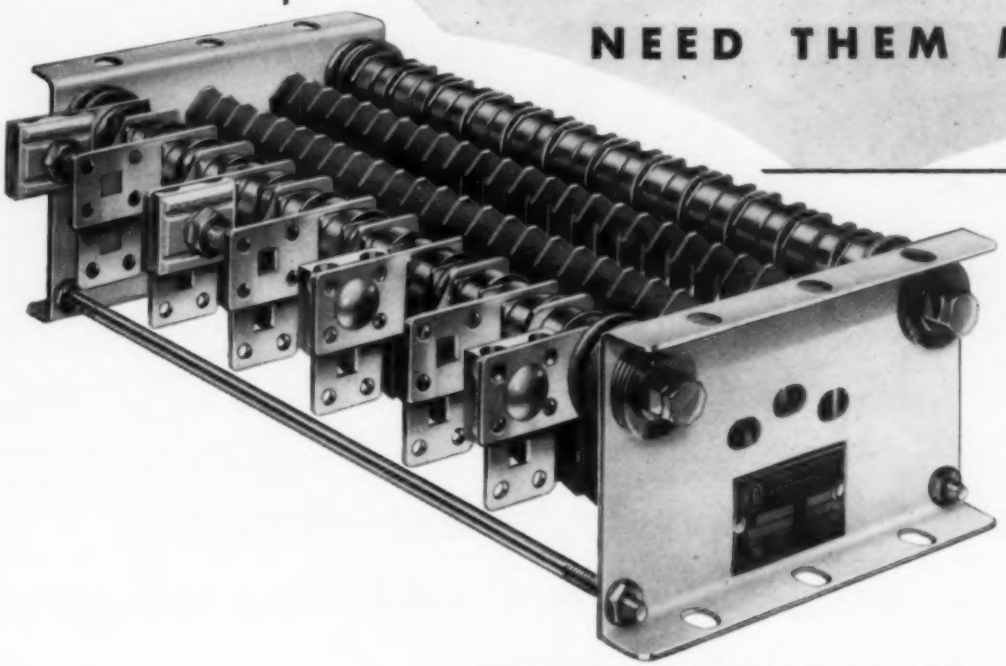
Since 1876

Executive Offices and Plant . . . . . **Cleveland, Ohio**
Executive Sales Offices . . . . . **Pittsburgh, Pa.**
Canadian Offices and Plant . . . . . **Hamilton, Ontario**
Cuban Office . . . . . **Santiago de Cuba**

Warehouses in Principal Cities

E, I and R Values

WHERE AND WHEN You NEED THEM MOST



- Steel Construction
- Mica Insulation
- Corrosion Resistant
- Vibration Proof
- Moisture Resistant
- Provision for Expansion
- Adequate Ventilation
- Rugged Terminals

The resistance grids used for P-G STEEL GRID RESISTORS are produced in a wide variety of values, thus the current requirements for accurate motor control are readily obtained. These resistors, built of steel and mica, are able to withstand vibration, moisture or corrosive fumes, and maintain remarkably constant electrical values. Hence, they are the "Trouble Free" resistors with the longer service life. Try P-G on your next application.

Write for Bulletin No. 500

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

Announcing– the new LPD design **Clipper Oil Seal**

The design of the new LPD Clipper Seal assures that the spring which controls the lip contact on the shaft will be held tightly in the seal. It further provides a husky lip section that enables better control of lip flexing, and better utilization of the full available depth of the lip section.

. . . with reinforced heel developed especially for equipment used by the iron and steel industry

HERE IS THE newly designed Type LPD Clipper Oil Seal that lasts longer and seals more effectively than any previous design. It runs cool, sealing tightly even when shaft speeds are higher and equipment variables wide.

The new Type LPD Clipper Oil Seal can be supplied with the special reinforced heel developed to withstand the severe jolting of back-up roll bearing service. Thoroughly field tested, this special Clipper Seal is now being used with unusual success on hot and cold rolling mills, finishing trains, rod mills, wire mills and similar equipment.

The longer life of this new Clipper Seal lessens replacements. It lasts longer and withstands higher shaft speeds because it requires less lubrication over its lip bearing area. Furthermore, the LPD design provides better utilization of the lip section of the seal—another factor in prolonging its life. And the greater flexibility of this lip section improves the performance of the seal.

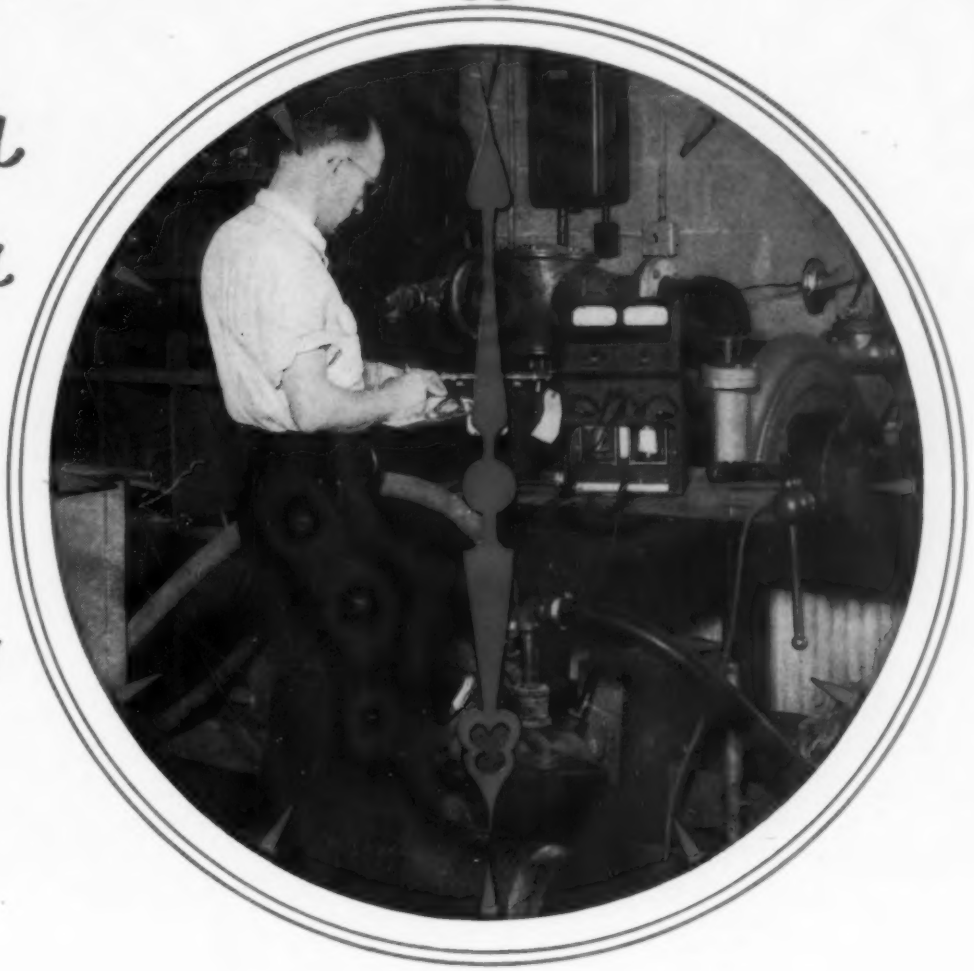
• • •

For more information about the new Type LPD Clipper Seal with special reinforced heel, write Johns-Manville, Box 60, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville CLIPPER SEALS**

ECLIPSE FUEL ENGINEERING WRITES:

"Heat Prover Completed a 30 Hour Burner Test In Just 6 Hours!"



Amazing Cities Service Heat Prover Works 5 Times As Fast As Old Method... More Accurate, Too!

Robert W. Pixler, Laboratory Supervisor for Eclipse Fuel Engineering Company, Rockford, Illinois writes:

"It did not seem possible that an instrument that is so fast and direct-reading could possibly have the accuracy we demand. But, we found the Heat Prover equally exact, possibly even more exact, than standard commercial testing equipment.

"Our test work with previous instruments was a long, drawn-out affair. But with the Heat Prover, we completed what would normally have been a 30-hour test in just 6 hours! ...and we doubt that our old equipment could have maintained the accuracy delivered by Cities Service Heat Prover."

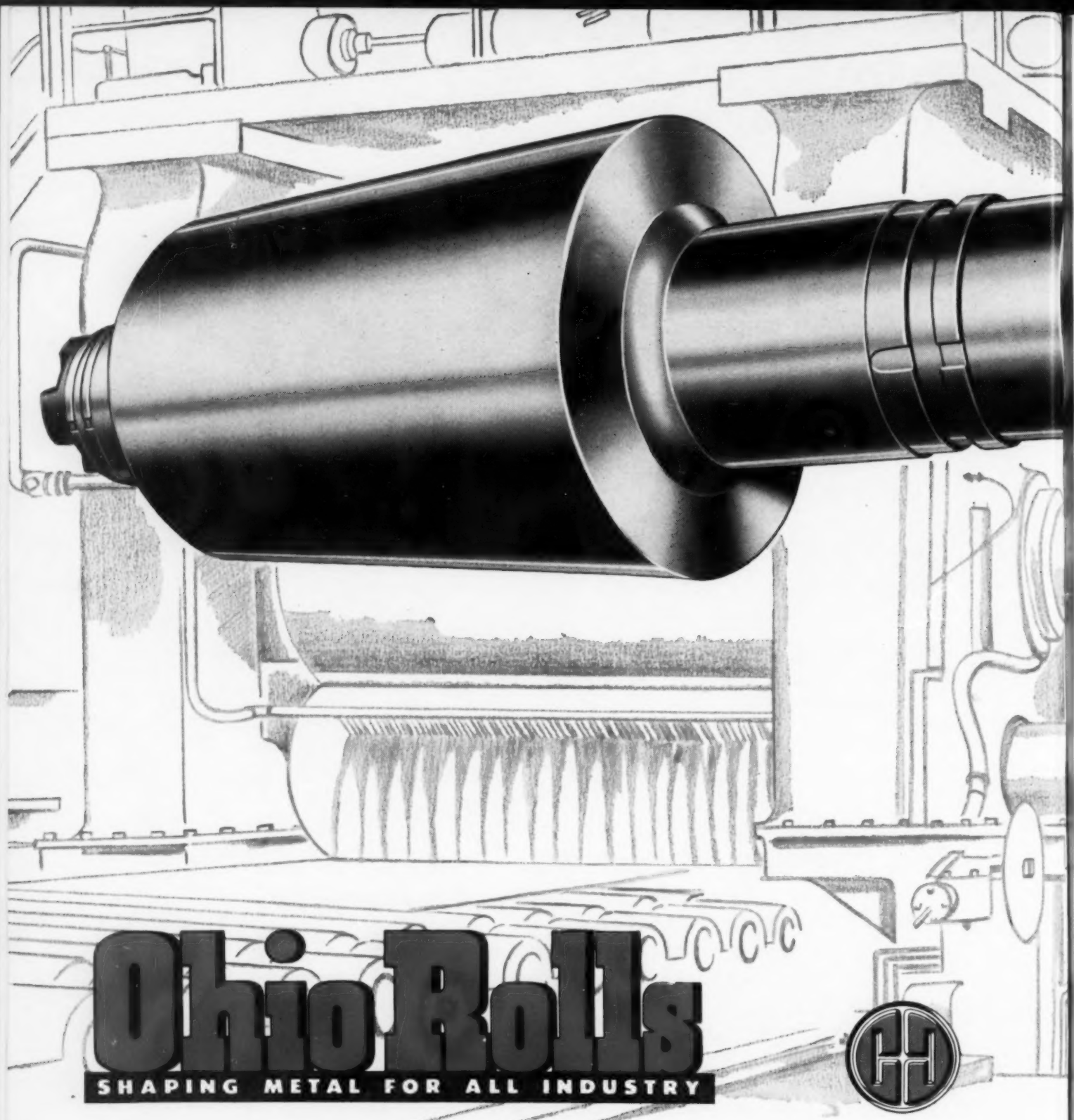
WHEREVER A FURNACE OPERATION IS INVOLVED, the Heat Prover can help increase productivity by providing:

- **Rapid, continuous sampling**
- **Simultaneous reading of oxygen and combustibles**
- **Direct measurement of oxygen and combustibles**
- **Easy portability**
- **No maintenance; no re-calibration**

For details, contact nearest Cities Service office or write Cities Service Oil Company, Dept. D11, Sixty Wall Tower, New York City 5, N. Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS



Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY

CARBON STEEL ROLLS • OHIOLOY ROLLS • OHIOLOY "K" ROLLS
HOLL-O-CAST ROLLS • CHILLED IRON ROLLS • DENSO
IRON ROLLS • NICKLE GRAIN ROLLS • SPECIAL IRON ROLLS
NIOLOY ROLLS • FLINTUFF ROLLS • OHIO DOUBLE-POUR ROLLS

THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO • Plants at Lima and Springfield, Ohio

Industry News...

AMERICAN STEEL AND WIRE BLAST FURNACE WILL BE BUILT BY ARTHUR G. McKEE AND CO.

▲ Contracts were completed with American Steel and Wire division, Cleveland, Ohio, to begin construction of the world's largest merchant iron blast furnace by the Arthur G. McKee and Co.

The new furnace, to be built at the Central Furnaces and Docks plant of this division of United States Steel Corp., will have a capacity of 1350 tons a day.

It is 106 ft high and has a 26-ft hearth. Construction will get underway immediately and it is expected the furnace will be completed in about fourteen months.

The contract covers the major portion of the complete blast furnace installation and consists of the furnace proper, three stoves for preheating the blast air to approximately 1400 F, stock house and handling equipment, gas cleaning equipment, including all foundations, gas and air mains, and utilities.

The most modern equipment for eliminating air and water pollution is provided for in the design of the furnace.

A primary water gas washer and a secondary electrostatic gas cleaner will remove ore and coke dust from the gas coming off the top of the furnace before it is reused to heat the stoves and underfire the boilers.

Millions of gallons of water used in cooling the furnace and washing the gas will be cleaned in special sludge removal equipment to return the water to the Cuyahoga River cleaner than when it was taken out.

Test borings of the soil at the site of the proposed new blast furnace at Cleveland's Central Furnaces and Docks have been taken by a consulting engineering firm. These samples have been analyzed at the University of Michigan's soil testing laboratories for data helpful to reducing cost of construction.

Location of the new giant furnace is to be in the Cuyahoga River Valley where the earth is a mixture of clay, gravel, and water-holding sand. These conditions present extremely difficult problems in engineering a foundation which will shoulder the tremendous weight of the furnace, its equipment, and other buildings to be constructed.

Seven test spots, which the engineers felt were critically located loadwise, were chosen. Out of these drill holes, approximately 150 samples of the earth were taken at various levels to a depth of 150 ft. At the University of Michigan's laboratories, the clay samples were given "shear tests" to determine friction value for carrying the load. The furnace alone when operating will weigh about 11,000 tons.

It has been determined that for the entire project, including new buildings and equipment, over one thousand piles will have to be driven into the ground. Inasmuch as each of the piles is figured to bear a 60-ton share of the load, they will have to be driven as deep as necessary to reach firm holdings on which to base the underpinnings of this new queen of merchant ironmaking.

While a solid bedrock exists at the minus 150-ft level, experiments are being carried on in the hope that methods can be developed to establish the foundation on a strata of clay at the minus 70-ft level.

DOWNTIME REDUCED BY NEW ALLOY ROLL

▲ Reduction of downtime, that bugaboo of every steel man from company president to the tonnage-paid worker on the mill, is the No. 1 target of a new hot strip mill work roll. The new alloy iron "M-H Anniversary Roll," made by Mackintosh-Hemphill Co., is increasing roll time in strip mill finishing stands over 50 per cent and in some extreme cases 200 per cent.

The roll is named in recognition of the 150th anniversary of the firm's founding in 1803.

Fred C. T. Daniels, vice president in charge of metallurgy and research, points out that the new roll can save a steel company several million dollars annually.

Secret of the roll's success in giving long service between redressings is a revolutionary heat treatment developed by the Pittsburgh firm. That treatment in effect modifies the usual procedure for imparting the physical properties to rolls of this type. The roll is double-poured hard and then tempered, instead of being poured initially soft and used in this condition. The Mackintosh process consists of casting the roll to a hardness of 82 scleroscope and then low-temperature heating, or drawing it back, to 75 scleroscope.

A modern 4-high hot strip mill normally consists of ten roll stands. The last six stands comprise the finishing train. In this finishing train,

HEAVY FORGING PRESS

A 1/16th scale working model of the 35,000-ton forging press to be built by E. W. Bliss Co. is shown here being inspected by R. Y. Moss, plant manager; H. U. Herrick, president; E. A. Irwin, sales manager and E. V. Crane, chief of special engineering. Model construction is proportional to the big press in every important detail, even to internal ribbing and welding methods used in fabricating the press. The model will be used for laboratory analyses of stresses developed under different load conditions, including strain gage and stress coat tests. It will also be valuable in working out the proposed assembly procedure for the big press, which will be located together with its 25,000-ton companion Bliss press at the Air Force plant in Newark, Ohio. This model stands 53 in. from top to bottom compared to 70 ft for the full-sized press. Actual working capacity of the model is 137 tons, equivalent to the weight of a large railroad locomotive. The 35,000-ton and 25,000-ton Bliss presses are being built at the company's Canton, Ohio, division and are part of the Air Force heavy press program.

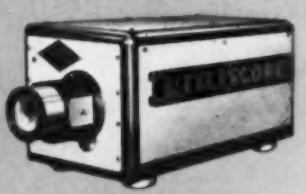
OFTEN THERE'S NO SUBSTITUTE FOR A GOOD LOOK

That's Why Industry Needs the DIAMOND "UTILISCOPE"
(WIRED TELEVISION)

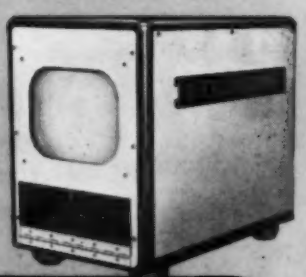
Vital and critical processes inside a furnace often are of such a nature that only a good look can make sure the conditions are right. There are many other operations and processes in industry where the statistical information offered by the best instrumentation is no substitute for a good look . . . places where instruments can't provide the REALISM necessary to correct judgment and decision.

The Diamond "Utiliscope" (wired television) enables the operator to have a "good look" at all times, no matter how distant, dangerous or inaccessible the operation. A clear image can be brought to any desired point. Images of separate but related operations can be shown side by side, so one operator can correctly coordinate them.

The "Utiliscope" is thoroughly reliable and not expensive. It cuts costs, improves operation, saves manpower and promotes safety. Write for Bulletin.



"Utiliscope" Camera (above) and Receiver (below)



TYPICAL USES—Studying destructive tests of engines • Watching flow of molten steel • Checking remote gauge readings • Observing conditions inside furnaces • Viewing nuclear research • Coordinating materials flow on conveyors • The "Utiliscope" (Registered U. S. Patent Office)

WRITE FOR BULLETIN 1025 B

DIAMOND POWER SPECIALTY CORP.
FIRST IN INDUSTRIAL TELEVISION
LANCASTER, OHIO • OFFICES IN 39 PRINCIPAL CITIES
Diamond Specialty Limited—Windsor, Ontario

6191

SINCE 1903, DIAMOND HAS MANUFACTURED QUALITY EQUIPMENT FOR INDUSTRY

fully-alloyed, hard cast iron rolls, at 80 scleroscope hardness have been customarily used in the last two or three stands. The preceding stands carry a low-alloyed roll at about 70 scleroscope. The new roll at 75 scleroscopic hardness is currently building its excellent service record in the first two or three roll stands of the finishing train.

In this application, savings in downtime can be translated readily into savings in dollars. A complex, modern wide strip mill, including all its auxiliaries, represents a vast outlay of money, with consequent heavy stand-by charges. These may be as high as $1000 per hr. When the rolls must be "pulled" for redressing, or when any single roll fails in service, the whole mill must be stopped while the rolls are changed.

Rolls in the first three finishing train stands are generally changed every 4 hr or less. The new roll during field testing remained in the mill without change for 8 hr — twice the length of time for ordinary rolls.

What does longer roll life between dressings mean to steel production? Just this: Changing rolls every 4 hr means six changes in 24 hr. Changing rolls every 8 hr requires only three changes in 24 hr.

On multiple changes 5 min is considered fast time for changing a pair of work rolls. Six changes in 24 hr consume no less than 30 min. Three changes — 15 min. This means a saving of 15 min per stand every 24 hr by the use of the Mackintosh-Hemphill roll . . . 15 min more rolling time every day.

Since the new roll is used in three stands, increased rolling time in the three stands would be 3 × 15, or 45 min per day. Assuming 300 continuous operating days in a year, the increased rolling time annually would amount to 13,500 min or 225 hr.

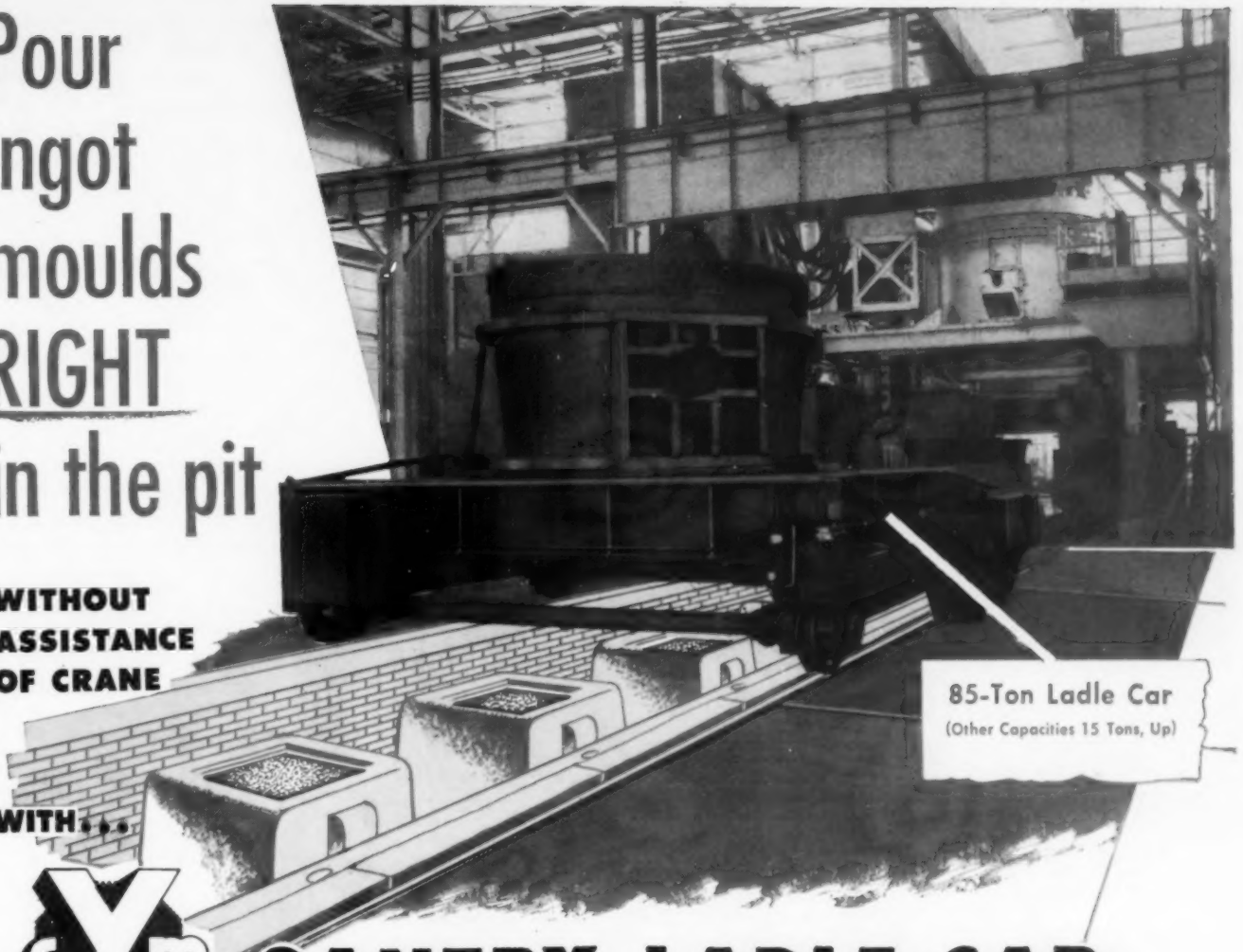
Modern hot strip mills roll about 300 tons of strip steel per hr. That means the excess tonnage produced on Mackintosh rolls can amount to 300 × 225 or 67,500 tons per year.

Strip steel sells for about $70 per ton. Multiply 67,500 by $70 and you get $4,725,000. This is the amount saved by regular finishing stand roll changes every 8 hr rather than every 4 hr. This figure can be directly attributed to the physical constitution of the newly-developed M-H Anniversary Roll used in the critical first three finishing stands of a hot

Pour ingot moulds RIGHT in the pit

WITHOUT ASSISTANCE OF CRANE

WITH...



Y F&M GANTRY LADLE CAR

relieves the "bottle-neck" caused by limited crane capacity

The 85-ton Gantry Ladle Car pictured is "paying off" in an eastern steel mill by speeding up pouring and improving plant efficiency. You can save time and money by using this modern economical method of increasing tonnage output.

these features

- ☐ Designed to Suit Your Ladle
- ☐ Sturdy Construction Throughout
- ☐ Positive, Simple, Push-Button Control
- ☐ Electric Motor Driven
- ☐ Moves on Track over Pit
- ☐ Roller Bearing Wheel Journals
- ☐ Easy and Economical to Operate

The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

10

BETTER LONGER!

RUN-OUT TABLE
ACTUAL SERVICE RECORDS
OF THREE YEARS
WITHOUT
MAINTENANCE

★ On run-out tables, as well as on other equipment, Lovejoy Flexible Couplings are giving outstanding performance. They feature free-floating load cushions suspended between heavy metal jaws. Cushions will last two to five years *and there is no shut-down for changing*. These couplings instantly counteract mis-alignment, vibration, backlash and surge. To eliminate costly break-downs and shut-downs due to coupling failure on run-out tables and other equipment, use Lovejoy Flexible Couplings. No lubrication ever required.

WRITE FOR COMPLETE CATALOG AND HANDY, QUICK-FINDING SELECTOR CHARTS

LOVEJOY FLEXIBLE COUPLING CO.

5093 WEST LAKE STREET CHICAGO 44, ILLINOIS

Also Mfrs. Lovejoy Universal Joints and Lovejoy Variable Speed Transmissions

strip mill. The improved condition of the steel coming from the new rolls enhances the life of the final three finishing stand rolls.

Steel mill engineers calculate roll change costs by another method too. They multiply the number of down-time hr saved by the hourly rating of the mills. Hourly rating is the same as stand-by charge referred to previously.

Assuming $750 per hr rating and 225 hr saved, the total savings would amount to $168,750.

In some plants, production lost during the actual shutdown for roll changes is only part of the story. The other part concerns the tonnage lost in bringing the mill back up to speed after the shutdown. On a high speed mill as much tonnage may be lost during deceleration and acceleration as was lost while the mill was idle.

The new roll is identified by wabblers painted in gold with a red stripe.

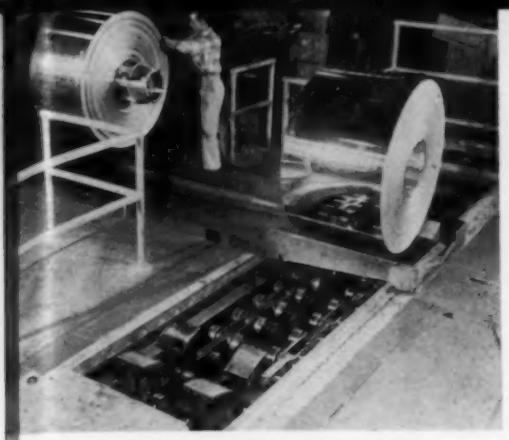
DISCUSS WASTE PICKLE RECOVERY PROCESS

▲ A new waste pickle liquor recovery process was described at a meeting of prominent steel industry men held recently at Blaw-Knox Co.'s Chemical Plants division.

Invented by Dr. Othmar Ruthner of Vienna, the new process has been improved and adapted to American engineering standards by Blaw-Knox. Dr. Ruthner was present at the recent meeting to take part in the explanation and discussion of the process.

With the large quantities of pickle liquor used in the steel industry (estimated at more than 600 million gal a year), the problem of disposing of this waste has become increasingly difficult and costly. For public health reasons, state governments forbid emptying waste pickle liquor into the streams.

The new Blaw-Knox-Ruthner process gives promise of solving the problem for the large steel producers both inexpensively and without producing other undesirable by-products which themselves might pose a disposal problem. This process recovers the entire sulphate equivalent of the waste pickle liquor as a re-usable sulphuric acid without the installation of an expensive contact or chamber sulphuric acid plant. The iron is recovered as essentially pure iron oxide, which is recharged to the furnaces.



NEW J&L CONVEYOR

Coils of tinplate are handled with "kid gloves" on a Link-Belt saddle-top conveyor at the entry to a shear line at the Aliquippa, Pa. works of Jones and Laughlin Steel Corp. This rugged conveyor, only 15½ ft centers, is one of the shortest in the industry, yet it illustrates the increasingly wide application of conveyors in keeping modern steel mills operating at peak capacity. It holds two coils as big as 72 in. in diam and weighing up to 40,000 lb each. Coils are lifted from the conveyor by a hydraulic coil buggy, which feeds them onto the pay-off reel. The arms of the coil buggy are shown beneath the coil at right. This conveyor was furnished by Link-Belt Co. through Aetna-Standard Engineering Co., Youngstown, Ohio.

FURNACE NO. 3 WORKING AT INDIANA HARBOR

▲ With its new No. 3 blast furnace in operation, Youngstown Sheet and Tube Co. has sharply increased iron production at its Indiana Harbor, Ind., works.

The furnace, with a hearth diameter of 28 ft, has a rated capacity of 1500 tons daily.

The new blast furnace is the third major unit to go into production since the company's Indiana Harbor expansion program was launched in 1950. The new open hearth department of eight 250-ton furnaces went into production last May and a new 75-oven coke battery began pushing coke last fall. A blooming mill and a cold rolling unit are under construction.

ANNOUNCE OPENING OF PITTSBURGH PLANT

▲Benjamin Lassman & Son announces the opening of their new plant and offices in suburban Pittsburgh (Route 8, Glenshaw, Pa.) The present expansion program of the company provides up-to-date facilities for engineering design and manufacture. The new production facilities will permit the continued manufacture of special industrial hydraulic equipment as well as allow the inclusion of standard components in the Lassman "heavy duty" line such as valves, cylinders, controls, etc.

EMPLOY STUD WELDING IN MATERIALS HANDLING

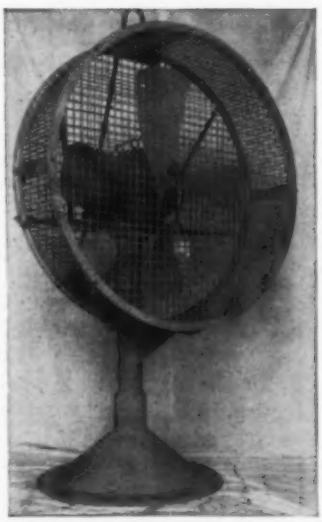
▲ The growing use of stud welding as a means of solving materials handling problems was highlighted recently as the National Tube division of the United States Steel Corp. showed how this technique has been used as part of the new "hot extrusion" process for the production of high alloy seamless steel tubing and shapes at its Gary, Ind. plant.

There, newspapermen and company officials saw how the Nelson stud welding gun has been employed to put headed studs or "handles" on the stainless steel slugs so that they can be suspended from conveyors for a trip through furnaces and salt baths where the temperatures up to 2300 F

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS



TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
245 MAIN ST., HARMONY, PA.

No other
Vapor-tite Fitting
offers so much!

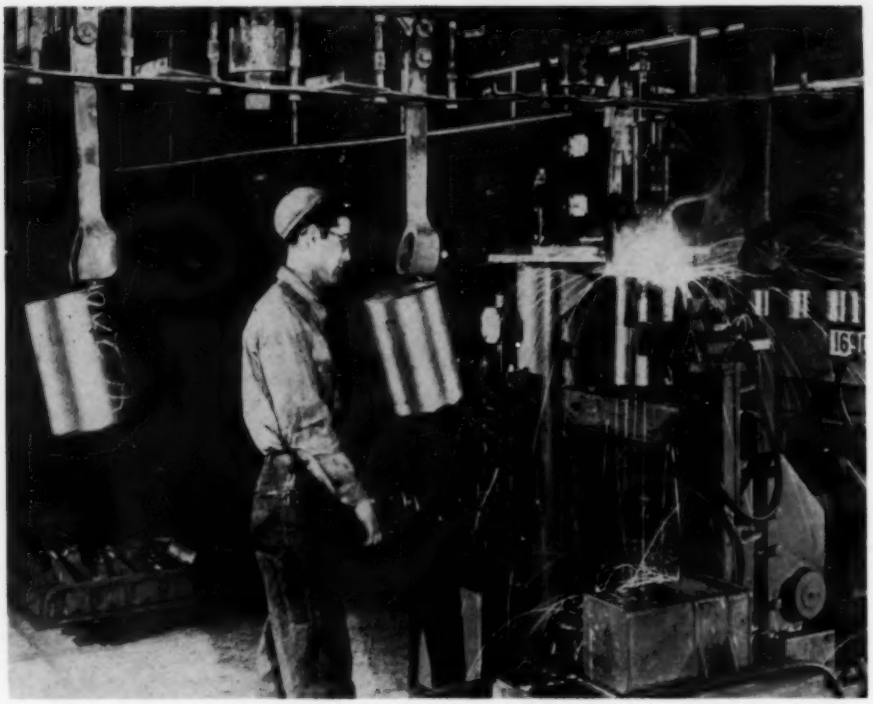
- Versatility – 4 hubs, 3 plugs
- Resilient neocork gasket
- Strong socket, big terminals
- Globe – clear, colored, heat resisting
- Cast guard with safety groove

. . . . and it can't rust – it's "Adalloy" – lowest maintenance.

Reflectors in all types

Bulletin E-5-52

THE ADALET MANUFACTURING CO.
CLEVELAND 11, OHIO



Hanger-studs are electrically welded onto the steel billets in order to move them by overhead conveyor system, similar to the type used in the automobile industry.

bring steel to heat necessary for extrusion.

This spectacular use of the speedy fastening technique, which has been widely adopted in the solution of other steel producing problems, parallels the techniques already in use by producers of overhead trolley conveyors and other handling equipment, as well as various metalworking industries, where extensions are end-welded to parts in process so that they can be more easily moved through manufacturing sequences.

In either case the cost of making such attachments is held to a minimum by the inherent speed and simplicity of stud welding equipment, produced by Nelson Stud Welding division of Gregory Industries, Inc., Lorain, Ohio. A granular flux is used in the majority of Nelson studs, which are simply chucked in a lightweight hand gun, placed against the workpiece, and permanently end-welded in place at the pull of the gun's trigger. The process is flexible, too, and attachments can be stud welded at any convenient point during fabrication, with the gun held in any position — overhead, vertical or downhand.

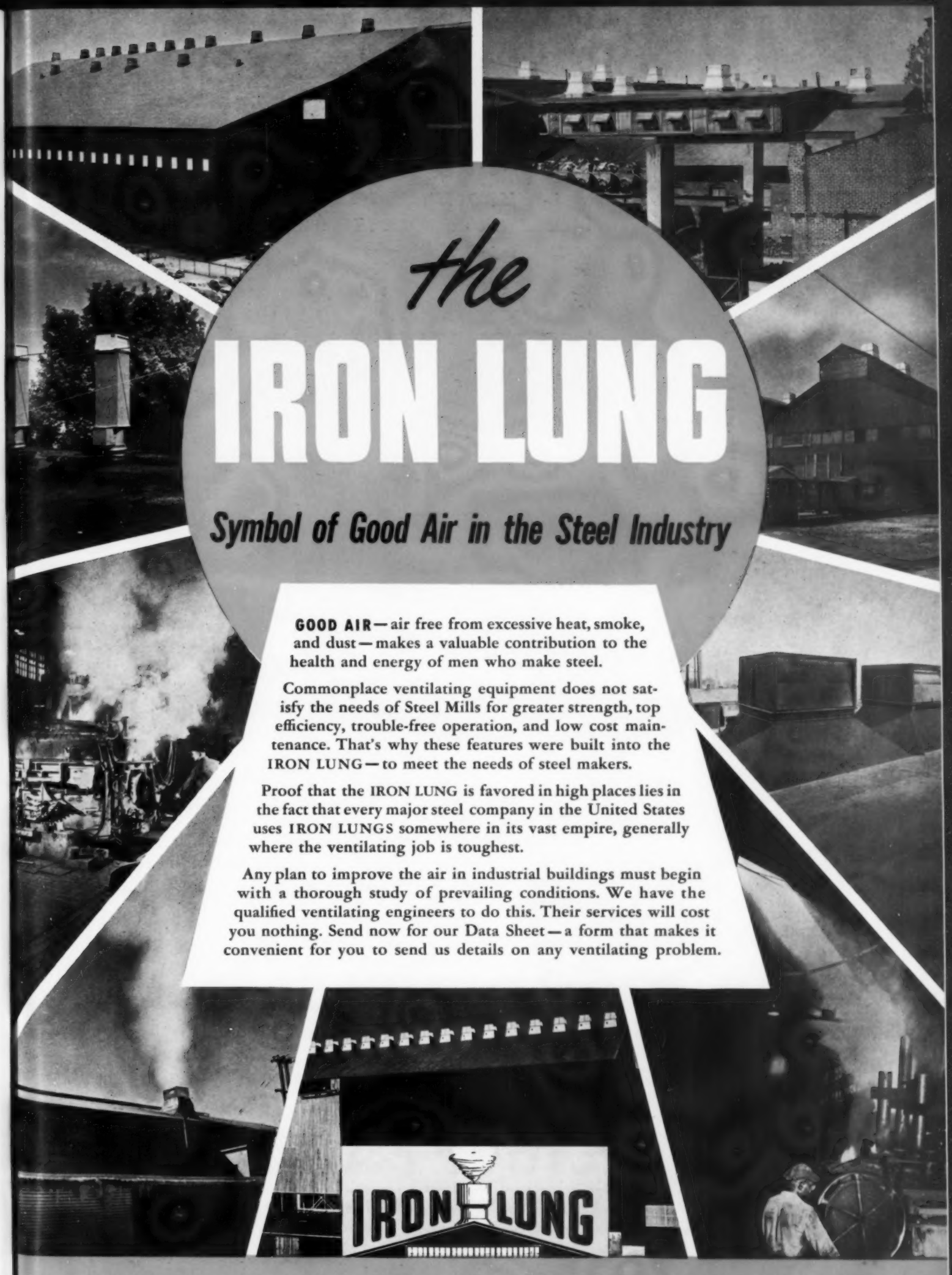
These three factors, then: (1) variety of hooks, hangers and other handling attachments now available for application by stud welding; (2) speed, economy and dependability of the method, and (3) simplicity and flexibility of stud welding, have lead to the widespread re-analysis of situations where attachments are being used or could be used to hang, hold or handle.

CRUCIBLE HEAD LEADS SEMINAR

▲ On March 3 in the Midland, Pa., High School auditorium, the supervisors of Crucible Steel's Midland works had a new instructor for one of their supervisory training meetings. William H. Colvin, president of Crucible, lead a seminar on the company's economic facts of life. He used as his text Crucible's 1952 annual report.

Before more than four hundred supervisors, Mr. Colvin reviewed Crucible's 1952 record. He covered the expansion and modernization program of the company and particularly of Midland works. He stressed the importance of this program to the security of the company, its employees and the communities where Crucible operates.

The meeting was then opened for questions. This was no ordinary question and answer period. Before the meeting began, the supervisors were divided into groups of twenty. Each group elected a chairman. After Mr. Colvin's talk, the groups held private buzz sessions. Working as a commit-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Symbol of Good Air in the Steel Industry
GOOD AIR — air free from excessive heat, smoke, and dust — makes a valuable contribution to the health and energy of men who make steel.
Commonplace ventilating equipment does not satisfy the needs of Steel Mills for greater strength, top efficiency, trouble-free operation, and low cost maintenance. That's why these features were built into the IRON LUNG — to meet the needs of steel makers.
Proof that the IRON LUNG is favored in high places lies in the fact that every major steel company in the United States uses IRON LUNGS somewhere in its vast empire, generally where the ventilating job is toughest.
Any plan to improve the air in industrial buildings must begin with a thorough study of prevailing conditions. We have the qualified ventilating engineers to do this. Their services will cost you nothing. Send now for our Data Sheet — a form that makes it convenient for you to send us details on any ventilating problem.
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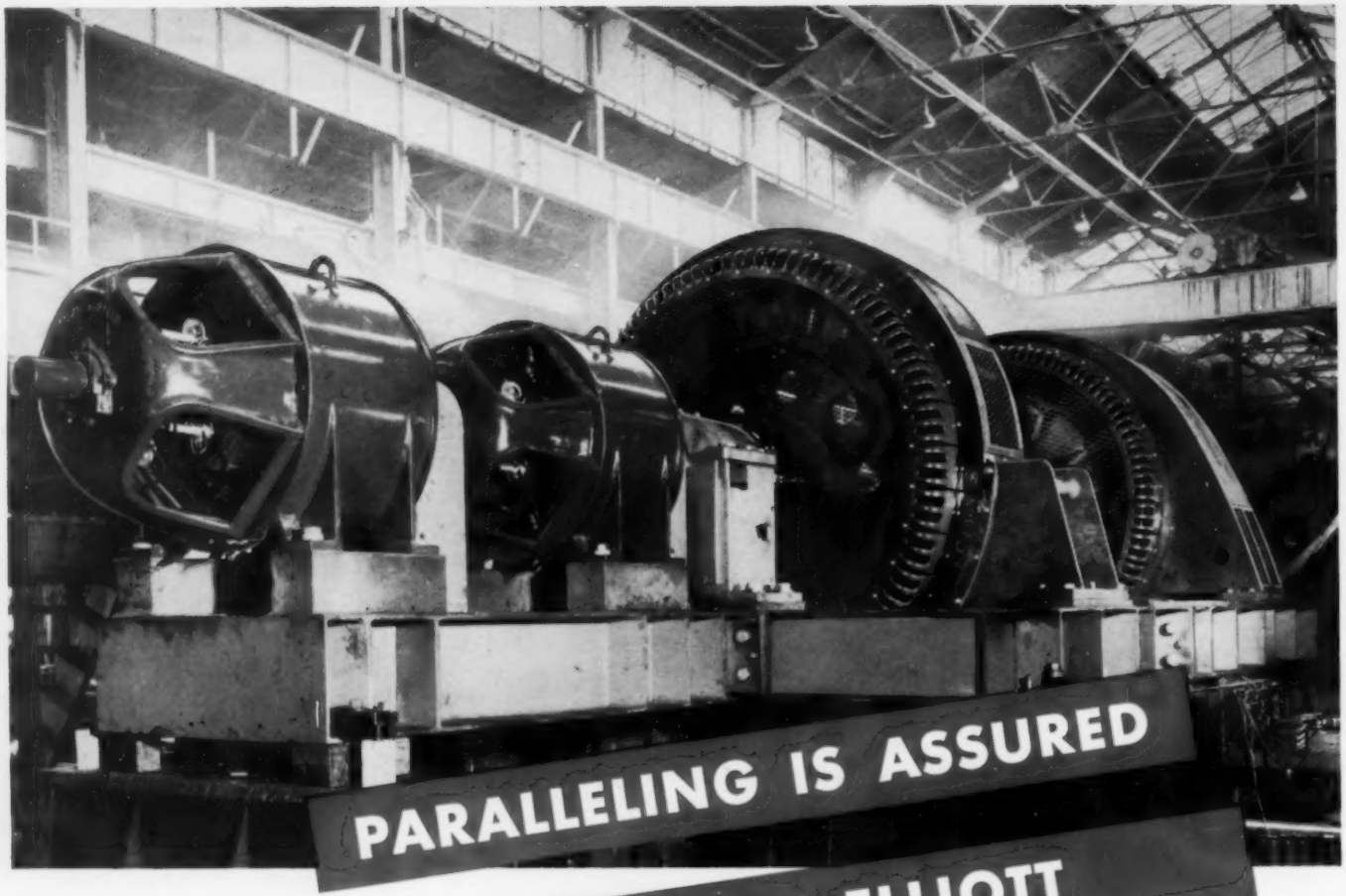
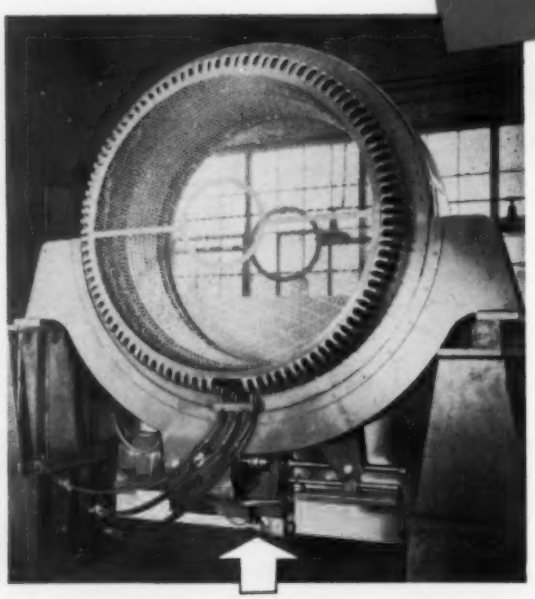


PARALLELING IS ASSURED WITH ELLIOTT

Synchronous Frequency Changers



A close up of the motor-driven shifting mechanism by means of which the generator stator is shifted by rotation in a cradle to establish the correct angular position for synchronizing. The stator shifting mechanism is furnished in one "package," making it readily removable as a unit assembly for convenience in maintenance.

• This large Elliott Synchronous Frequency Changer is one of a pair which operate in parallel while converting electric power from 25 to 60 cycles in a large Midwestern steel mill. Each set, with individual exciters for motor and generator, has an output of 1250 kva at 60 cycles. Paralleling is an assured, positive operation with this Elliott "team" because of careful design and precision workmanship. These essentials to performance are characteristic of all Elliott electrical equipment. For details write Elliott Company, Ridgway Division, Ridgway, Pa.

Elliott FABRI-STEEL MOTORS AND GENERATORS

R3-20

ELLIOTT Company

RIDGWAY DIVISION

FOR MOTORS 1-200 HP: CROCKER WHEELER DIV. AMPERE, N. J.

tee they developed the two most important questions they wanted Mr. Colvin to answer. At the close of the talk, each group chairman was invited to the front of the auditorium. There, one by one, they asked the questions picked by their group. And, Mr. Colvin gave answers to the questions that were uppermost in the minds of the plant supervisors.

Mr. Howell, general superintendent of Midland works, was chairman of the meeting. Assistant general superintendent, George Burrier, who is chairman of Midland training committee, organized the question and answer program. The entire program was conceived and planned by the Midland plant training committee and arrangements for it were under the direction of a general committee on arrangements made up of management employees of Midland works.

SMOKE CONTROL UNIT OPERATING AT FONTANA

▲ Smoke control equipment on one of the giant open hearth furnaces of Kaiser Steel Corp. went into operation this month at the company's steel plant, Fontana, Calif. Short test runs showed the equipment eliminated from 50 to 70 per cent of the smoke rising from the 175-ft stack of Furnace No. 3. After tests and adjustment of the equipment, which will take some two or three months, the control unit is expected to remove at least 95 per cent of smoke particles going into the air, it was stated by installing engineers. A second smoke control unit is on order for Furnace No. 9 and will be put in operation this summer.

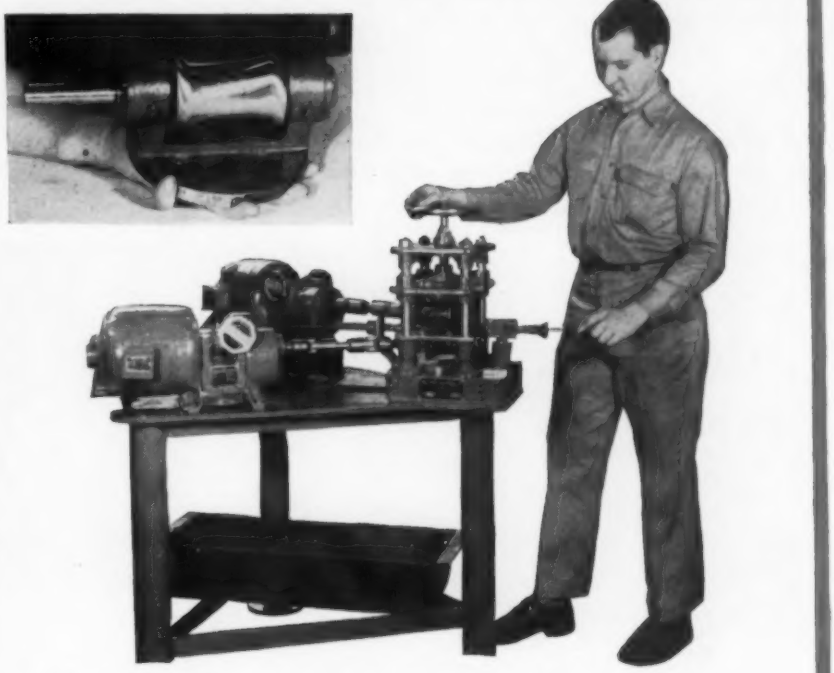
Research on the installation of these units has been going on since 1949, based on studies made at the plant since 1942. The control units are cottrell electrostatic precipitators, built and installed by the Western Precipitation Corp. Specifications for the units were submitted by Kaiser engineers after consultation with plant engineers and members of the Stanford Research Institute. Also collaborating were engineers from other steel companies and scientists from other institutes.

In operation, the gases are first cooled from temperatures approaching 1700 F down to about 600 F by means of newly constructed waste heat boilers. Then the gases and smoke are forced through two large

We Build Small Ones Too!

MEDART

No. 000 TWO-MOTOR TYPE
2-ROLL ROTARY STRAIGHTENER
FOR ROUND TUBES & BARS 1/16" TO 3/16" O. D.



• The smallest mill duty 2-roll rotary precision straightening machine made. Straightens, sizes, polishes and corrects out-of-roundness from end to end.

• Individual roll drive from variable speed motors equipped with integral speed reduction units, and interlocked for synchronization of roll speeds.

• Rolls made of Smavroc Alloy. Timken Bearing equipped.

Large Or Small—Medart Builds Them!

2-Roll Rotary Straightening, Sizing & Polishing Machines for tubes and bars from 1/16" to 9" or larger—or multiple-roll straighteners for pipe or thin-wall tubes up to 24". Whatever the straightening job, a Medart machine will do it *faster, better and at lower cost!*

Write For Catalogs

THE MEDART COMPANY 3535 DE KALB STREET ST. LOUIS 18, MISSOURI

chambers measuring, over-all, forty by twenty by twenty feet in size. These chambers hold steel rods and curtains carrying up to 75,000 volts of electricity. When passing through the chambers, the smoke particles are attracted to the steel curtains and drop down while the cleansed gases are returned to the stack. First investment in these smoke control units will come to a million and a quarter dollars.

Since 1942, Kaiser Steel has invested some $4,000,000 in other dust and smoke control equipment for its blast furnaces, coke ovens, raw materials plant, and other operations not including the open hearth furnaces. A staff of thirteen engineers and chemists now devotes full time to problems encountered in air control and research.

Up till 1949, when plant engineers at Kaiser Steel turned to the problem of controlling stack emissions from open hearth furnaces, little progress had been made throughout the steel industry regarding installations for large furnaces. Other steel companies since then shared their findings on installations on 45–50 ton furnaces, but these findings had to be translated to apply to furnaces four and five times larger and which use hot metal, such as those at Kaiser Steel.

In connection with the study of air control, the company established in 1943 the first of four stations in the immediate vicinity of the plant in which the presence of sulphur gases was measured and logged daily. As a direct result of these studies, the company effected controls which have so reduced the sulphur in the atmosphere that the average figure recorded is well below the threshold established as being harmful to vegetation or animal life.

BEGIN CONSTRUCTION ON NEW RESEARCH UNIT

▲ Another step in its long-range building program here was taken by Air Products, Inc., March 20 when ground was broken for the first unit of a research laboratory. Site of the new building is on a 31-acre tract in the extreme southeastern part of Allentown, Pa. Construction will begin immediately.

The unit is the first of six which will eventually comprise the entire Air Products research department. It will be one story in height, of brick and block construction, and will house a library, office space, and laboratory. Dr. Otto J. Stern was recently named air products director of research.

The first unit is the forerunner of the company's future expansion on the site. Eventually it is expected that all Air Products activities in this area will be centered in the location.

Air Products came to Emmaus, Pa., in 1946, locating in several of the then vacant Donaldson Iron Works buildings. The former Convair plant was leased in the summer in 1951 and became Plant 2. About 60 persons were employed when the company began its local operations. Today Air Products has more than 700 employees.

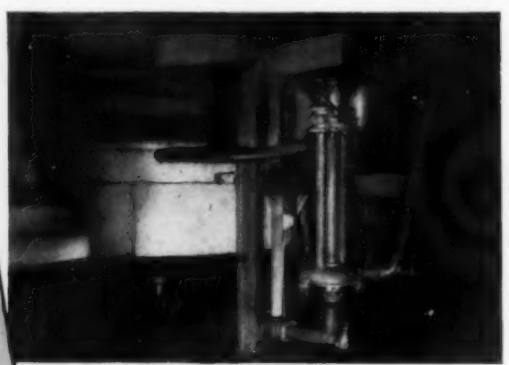
The company has industrial gas manufacturing plants in Iselin, N. J., Parkersburg, W. Va., and Walkerton, Ind., and is planning erection of another in Chicago, Ill. In addition, it owns the K-G Equipment Co., manufacturer and distributor of welding and cutting equipment and industrial gases.

HARRISBURG STEEL ACQUIRES BUTLER FIRM

▲ Harrisburg Steel Corp. has acquired Heckett Engineering, Inc., Butler, Pa., and its wholly owned subsidiary, Heckett International, Inc. By acquisition of the Heckett interests, Harrisburg Steel has taken another step in diversifying the activities of a company whose origins go back 100 years. Boiardi Steel Corp., Milton, Pa., manufacturer of steel bars, was acquired by Harrisburg Steel in September 1951.

To the present list of Harrisburg Steel products — which include high-pressure seamless steel cylinders, seamless pipe couplings, drop-forged flanges, commercial drop forgings, liquefied petroleum gas cylinders, and small steel bars — is now added Heckett Engineering's operations in the handling and utilization of steel works slag, and reclamation of the metal contained therein. This recovered metal is sold back to the steel companies concerned for considerably

This NEW Nagle "TV" PUMP is NO "WALLFLOWER"



IT'S prim and clean, and designed to mount on wall or side of a tank or sump, but it's no "wallflower." You'll find it in the thick of things! A single stage, bottom entrance, vertical shaft, dry pit pump for handling abrasive mixtures and corrosive liquids and slurries — pumps anything that will flow. The Nagle type "TV" gives you:

- Freedom from leakage—clean floors assured
- No stuffing box
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- Sizes from ¾" to 10"
- Capacities to 4,000 g.p.m.

Send for Bulletin "TV"

NAGLE PUMPS

NAGLE PUMPS, INC.
1263 Center Ave., Chicago Heights, Ill.

PUMPS FOR ABRASIVE AND CORROSIVE APPLICATIONS

less than the prevailing market price of heavy scrap, for which the recovered steel serves as a substitute.

NEW HEATING TECHNIQUE ANNOUNCED BY ALCOA

▲ Using ordinary household electric power, Aluminum Co. of America has succeeded in heating a 7700-lb aluminum ingot to working temperatures nearly 15 times faster than it could be done in a conventional furnace.

The announcement came today from Donald I. Bohn, chief electrical engineer. He has been in charge of Alcoa's low-frequency heating development, which has been underway for 10 years.

Mr. Bohn said the new technique of 60-cycle induction heating will be invaluable in heavy press production of big aircraft aluminum forging and extrusions.

Until this low-cycle method was developed, Alcoa used conventional methods, such as soaking pits or other furnaces, in all its operations to bring ingots to proper forging or extrusion temperatures.

Heating a 7700-lb aluminum ingot to 750 F, by conventional means, requires about 12 hours, as compared with the 50 minutes for the low-frequency induction method. In essence, the new method consists of placing an unheated ingot in a specially designed electrical coil.

Electric energy of commercial frequency is then applied to the coil. The electric current flowing through the coil induces a heavy current in the ingot itself, and this produces the temperature rise in the metal.

When Alcoa first started work on low-cycle induction heating, low-frequency coils were considered impractical and inefficient. Induction heating then used only current of higher than commercial frequencies, requiring expensive conversion equipment.

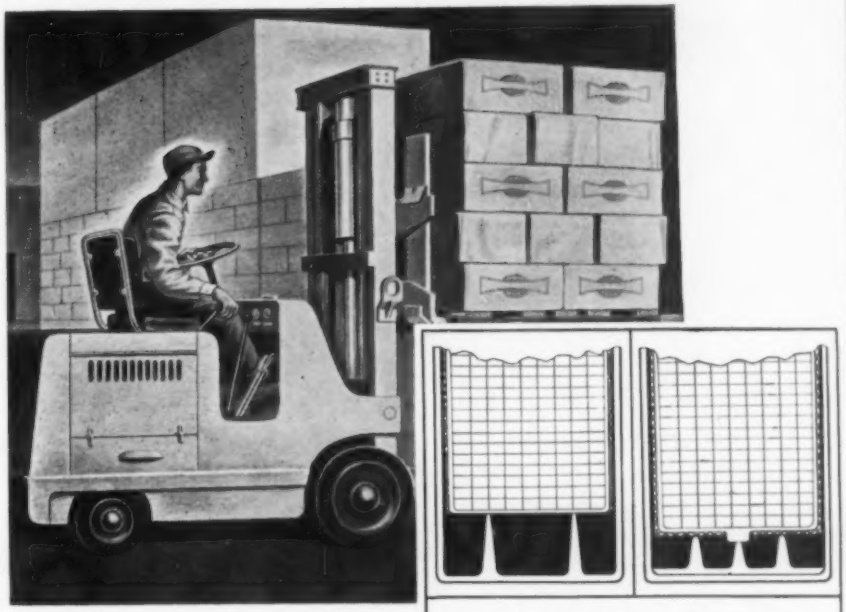
The first work was with 9600 cycle coils. As experiments continued, 1000 cycle coils were used, then 360, 180 and finally, 60 cycles, the same frequency as household current.

With each successive drop in frequency, Alcoa was able to improve, rather than decrease efficiency.

Mr. Bohn said this low-cycle induction heating method compares favorably with installation and operating costs of conventional equipment.

Induction heating, he added, per-

With C&D *Slyver-Clad** Batteries
it's all work and no play



COMPARE THEM! At left: an ordinary battery with large, unproductive sediment space and integrally molded supporting ribs. At right: a C & D Slyver-Clad showing longer, power-producing plates. Separate rib plate in new double bottom design distributes battery weight evenly over jar base. Negative plates rest on separate center rib.

With C&D Five-Fold *Slyver-Clad* Batteries you get full shift operation with your Electric Trucks. Their added capacity provides ample power for a heavy duty cycle under all power consuming requirements. And the high capacity and sustained voltage characteristics provide maximum desirable truck speeds for the duty cycle.

This added capacity is made possible by C&D's Five-Fold *Slyver-Clad* method of insulation and retention. The active material is held in place on the positive grid, and sedimentation is virtually eliminated. Normal battery sediment space is reduced, permitting longer and heavier plates, giving from 10 to 30% more capacity in the same size tray.

As Five-Fold *Slyver-Clad* construction virtually eliminates "shedding", C&D Batteries maintain their capacity longer than conventional batteries, with a minimum of 80% of capacity at the fag end of a long life.

*Trade Mark Registered

C&D
BATTERIES, INC.
OF CONSHOHOCKEN, PA.
(In the Philadelphia Area)
SALES AND SERVICE OFFICES IN
PRINCIPAL CITIES FROM COAST TO COAST

5th NATIONAL
MATERIALS
HANDLING
EXPOSITION
MAY 18-22, 1953
PHILADELPHIA

THIS PICTURE TELLS A STORY of a new cost-cutting opportunity for steel mills

Note the ready accessibility of each item of steel in this storage yard of a well-known steel mill. It's this availability of materials that's one of the prime advantages of the ROSS STRADDLE CARRIER handling method . . . an advantage, unmatched by any other method, that eliminates delays, lowers costs and increases the production efficiency of the mill.

ROSS STRADDLE CARRIERS, heart of the Ross unit-load handling system, are built to handle 45,000-pound concentrated loads on around-the-clock schedules in the roughest, toughest steel mill service . . . to put those loads *where* wanted *when* wanted.

Your mill, too, can profit by this modern, flexible mass handling system. Get in touch with Ross today for the complete details.

Rely On ROSS

THE ROSS CARRIER COMPANY

Direct Factory Branches and Dealers Throughout the World

400 MILLER ST., BENTON HARBOR, MICH., U.S.A.

mits use of equipment smaller than conventional methods require. The induction heating method provides increased flexibility in operation of big forging or extrusion equipment.

Mr. Bohn said the coil also can be used for annealing and heat-treating fabricated products.

BEGIN CONSTRUCTION ON NEW WAREHOUSE

▲ Joseph T. Ryerson & Son, Inc., has announced that construction had begun on a completely new and much larger steel service plant for the firm's operations in Milwaukee, Wisc.

Property at South 84th St. and the Milwaukee R.R. is the site of the new building which will replace the present plant at 320 South 19th St. from which the company has been doing business in the Milwaukee area since 1925 when the former Reed-Smith Co. was bought by Ryerson.

The new steel service plant, which will consist of two large building units and an office building on attractively landscaped grounds, will have approximately 166,000 sq ft of floor space which is about three times the present plant capacity. The plant will be heated, to preserve and protect the finish of special quality steels and also for greater comfort of employees.

Much new equipment for cutting and handling steel will be installed, including a powerful high speed friction saw for cutting structural steel shapes, an electric eye machine for flame cutting heavy steel plate, and new plate shearing equipment. According to a company spokesman, all of this involves a very sizable capital expenditure in itself as evidenced by the following representative costs; friction saw complete with roll tables, about $52,000; plate shear fully equipped and with roll tables, about $60,000; travograph flame cutting machine equipped with electric-eye control and tables, about $20,000.

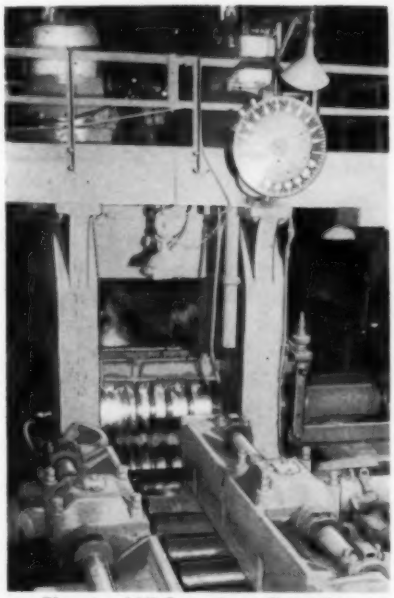
The new plant is scheduled for completion early in 1954.

BATTERY "13" CHARGED AT CLAIRTON WORKS

▲ The first coal was charged into the ovens of the new No. 13 coke battery on March 16, at U. S. Steel Corp., Clairton, Pa. This is the second battery of ovens to be completed this year at this plant.

Control room in large steel plant showing EC&M TAB-WELD Resistors used with mill controllers.

...and not one cent for maintenance



Blooming Mill Screwdown Controller —EC&M Bulletin 925 Mill Type with LINE ARC Controllers and TIME CURRENT Relays—famous for low upkeep, too.

Throughout this large steel mill, thousands of EC&M TAB-WELD Resistors have been giving trouble-free service on hard-worked, heavy duty applications. Not one cent has been spent for maintenance — NO BURNING.

When an accident smashed the end-frames and spacers of two sections, there was NO LOSS in production. Even under the damaged condition, the circuit remained intact due to TAB-WELD'S all-welded construction.

Also important are—the many taps which make on-the-job connections or adjustments easy. And, too, these resistors are corrosion-resistant.

For topmost performance specify EC&M Bulletin 942 TAB-WELD Resistors.

THE ELECTRIC CONTROLLER & MFG. CO.
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Industrial Cut Gears

FOR ACCURATE TRANSMISSION OF *POWER*

Whether the machinery or equipment is arranged for continuous or intermittent operation—the gearing must transmit the predetermined load without compromise.

"Industrial Cut Gears" can be depended upon to deliver full calculated power wherever installed . . . on machine tools, steel mill equipment, tractors, road machinery, shovels, cranes, farm machines, trucks, etc.

If you are not already using "I-G" or "I-G Durocase" Gears, specify them for all general or heavy-duty steel mill service. You will obtain results that are outstanding.

Send us your specifications for a prompt quotation on your requirements. Also write for Brochure "A Pictorial Trip Through Industrial Gear."

MEMBER OF AGMA

Industrial Gear Mfg. Co.

4527 W. VAN BUREN ST.
CHICAGO 24, ILLINOIS

The 61 ovens of the new Koppers unit will use 1400 tons of coking coal to produce 966 tons of coke daily. Coal chemicals and coke oven gas will be recovered as by-products of the coking process.

Blast furnaces of U. S. Steel plants in the area will consume the coke while the coke oven gas will fire open hearth and reheating furnaces. Coal chemical recoveries will be shipped to chemical processors.

The new gun-flue battery has self-sealing doors, newest type oven machinery and double collecting mains.

No. 15 battery, now nearing completion, is scheduled to push its first coke in May.

LECTROMELT TO PRODUCE SWEDISH FURNACES

▲ Pittsburgh Lectromelt Furnace Corp. has been exclusively licensed in the United States to produce electric induction furnaces developed by Allmanna Svenska Electriska Aktiebolaget (ASEA) of Vastera, Sweden, according to announcement by William Wallis, Lectromelt's president.

The licensing makes Lectromelt the second manufacturer of this type of melting furnace in America. The Pittsburgh company for many years has been a leader in production of electric equipment for melting metals and the addition to its line is in keeping with the firm's policy of offering a complete line of such apparatus, according to Wallis.

As successfully developed by Sweden's ASEA since 1926, its high frequency induction furnace is essentially a thin walled crucible surrounded by a specially designed coil of water-cooled copper tubing. After the crucible has been charged with melting stock — a large furnace unit will melt a 12-ton heat at five tons an hour — an alternating current of controlled frequency and intensity is sent through the coil. An induced magnetic field then penetrates into the charge and rapidly heats and melts it.

Power for the furnace is supplied by a high frequency generator which varies in size depending upon the holding capacity and melting rate of the furnace. Lectromelt is cataloging the induction furnaces in 11 sizes with nominal charge capacities from 500 lb to 15 tons.

Among advantages claimed for high

REVOLUTIONARY NEW MAGNET CHAIN LASTS 5 TO 15 TIMES LONGER!

The new TM Frictionless Magnet Chain is now being manufactured by the S. G. Taylor Chain Company, Hammond, Indiana. Patented design keeps chain legs at 120° centers — prevents undue wear that otherwise results from friction, due to twisting. The entire assembly is manufactured from Taylor's Special Analysis Alloy Steel. This assures twice the strength — twice the safety factor of wrought iron assemblies. Controlled heat-treatment means uniformity throughout plus high resistance to shock, grain growth and work hardness at *all temperatures.* And TM Alloy Steel Chain's extreme hardness enables the assembly to withstand abrasion. These factors add up to lower Magnet Chain costs for you as they have for others in many industries. Write today for full details. S.G.Taylor Chain Co., Hammond, Ind.

MINIMUM WEAR
Special locating plate keeps legs at 120° centers—cuts friction, twisting and gouging.

RUGGED CONSTRUCTION
Ring and end link can not be separated. Entire assembly is made from TM Alloy Steel.

- *Lasts 5 to 15 times longer.*
- *Provides Increased Safety Factor.*
- *Assures Twice the Strength.*
- *Means Lower Costs for You.*
- *Each chain is tested before shipment.*

TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

S. G. Taylor Chain Co.
Dept. 5, Hammond, Indiana
Rush literature and prices on TM Alloy Steel Downtown Magnet Chain.

Name_____

Address_____

MEET THE BRIGHT, NEW MATHEWS LOADSTAR

A Spectacular Performer in the Fine Trolley Field

This completely new trolley conveyer, designed to meet the requirements of the most discriminating buyer, is the result of five years of intensive development by Mathews Engineers. The top-quality precision wheel, with hardened races, is the heart of this rugged newcomer to the fine 4" trolley conveyer field. For the overhead conveying job that demands stamina and exceptional performance, we believe the No. 4207 Loadstar is without equal anywhere.

Ask your Mathews Engineer for complete information.

MATHEWS CONVEYERS

GENERAL OFFICES
Mathews Conveyer Company . Ellwood City, Penna.
PACIFIC COAST DIVISION
Mathews Conveyer Company West Coast
San Carlos, California
CANADIAN DIVISION
Mathews Conveyer Company, Ltd. . Port Hope, Ont.
Engineering Offices or Sales Agencies in Principal American and Canadian Cities

frequency induction furnaces are their special adaptability to the melting of alloy steels, stainless steel, tool steels and similar products. Many such furnaces are used, however, for smelting in the gray iron field. The induction furnace also is very flexible in operation and is particularly adaptable to the manufacture of small alloy steel castings.

J & L PLANS PROGRAM FOR EMPLOYEE AWARDS

▲ Jones & Laughlin Steel Corp. has announced it is putting into effect two programs for making cash awards to employes for suggestions and "proposals."

One, a suggestion plan, provides for cash awards to hourly-paid employes for suggestions on job improvements and improved operating methods. Under this plan, the employe submits his suggestion through the use of suggestion boxes placed throughout the mills.

The second, a work simplification award plan, provides for cash awards to salaried employes for their proposals on improving jobs and methods. Under this plan, the salaried employes submit proposals to work simplification committees.

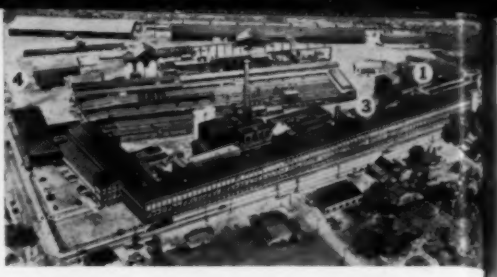
Awards are based on savings to the corporation as the result of an employe's suggestion or proposal. They are evaluated by various levels of management.

Both of the plans have been put into effect in the corporation's three steel plants at Pittsburgh, Pa., Aliquippa, Pa., and Cleveland, Ohio, and in the general offices in Pittsburgh. The plans are being put into effect in J&L's mines, quarries and all other operations as rapidly as possible.

TO COMPLETE EXPANSION PROGRAM THIS YEAR

▲ A building expansion program, started in 1946, which will add a total of 180,000 sq ft to present manufacturing facilities of the Crouse-Hinds Co., Syracuse, N. Y., will be completed this year.

In 1950, the company completed the first phase of its overall expansion program. A 74,000 sq ft building, an addition to present plant facilities, was constructed to house new screw machine and general machining departments as well as new pattern and



tool making shops. The new structure enables Crouse-Hinds to continue its production machining, pattern making, and special tooling operations in more volume and with increased efficiency.

Second phase of the building program, two new buildings totaling 61,000 sq ft, was completed last year. A heavy machining department and assembly facilities (2) for explosion-proof electrical products and traffic signals were added to the main building. Alongside the rear of the main building, another addition (3) was constructed to house a materials testing and electrical laboratory and a new finishing department.

Final phase of the expansion program, construction of a new 45,000 sq ft foundry, (4) is underway now and will be completed by next fall.

ANNOUNCE APPOINTMENT OF CANADIAN AGENT

▲ The appointment of Peerless Brothers Agencies, Ltd., as Canadian representatives for Continental Equipment Co., Coraopolis, Pa., was announced recently.

Better service to customers in the Provinces of Alberta and British Columbia will be gained with this appointment. Headquarters for Peerless Brothers are in Vancouver, British Columbia, with district manager, C. W. McLean located at Calgary, Alberta, Canada.

EHRET & KINSEY OPEN MILWAUKEE OFFICE

▲ Ehret and Kinsey, Chicago, Ill., who represent the Cleveland Worm & Gear Co., and Farval Corp., announce the opening of an office at 2400 West Clybourn, Milwaukee 3, Wisc., telephone Division 2-7844.

Ehret and Kinsey have been representing these two companies in this area for twenty-six years.

Their Milwaukee office will be in charge of James A. Gramling, an engineer who has been calling on the industrial plants in the Wisconsin area for a number of years.

NOW Crane Collectors Last *MONTHS*... Instead of Weeks

KEYSTONE TYPE XVI

COLLECTORS CUT DOWN TIME, WORK STOPPAGE, AND COSTS

A large New Jersey corporation had a serious current collector replacement problem on its foundry crane. Ordinary collectors failed after one week's service! Production stopped, but furnaces still burned, as workers climbed up to make replacements.

Loss in production and labor time prompted the company to find a better current collector. Keystone Type XVI Collectors were recommended and installed. Now collectors *last months* before replacement is required! Production is up with a minimum loss of labor time.

Some Keystone Type XVI Collectors have lasted 25 times longer than ordinary collectors. Features include, inexpensive carbon contact easily removed by backing out two set screws. Large contact area is non-arcing, noiseless, self-cleaning and self-lubricating. Provides constant contact, longer life. Housing consists of two aluminum castings with large radiating fins to provide lower operating temperatures. For all sizes of trolley wires up to 4/0 incl.

If you have a similar current collecting problem in your plant, find out about Keystone Type XVI Collectors. Write us today for latest, illustrated folder on Keystone electrical products.

ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA.

Manufacturers of complete line of insulator supports for rail and wire conductors and current collection devices.

BIG LIFT

FOR ALL INDUSTRY

MASSIVE RUGGEDNESS • POWERHOUSE STRENGTH • EASY HANDLING

These are the features that make STEARNS Circular and Rectangular Lifting Magnets successful and profitable in handling steel sheets, plates, bars, rails, slabs, billets, pig iron, castings, borings, turnings, scrap iron, or finished products.

Move large quantities of material fast — at low cost — with a STEARNS Lifting Magnet. It will pay for itself quickly, require little attention, and will fulfill your requirements for economical, fast and safe movement of material.

STEARNS Lifting Magnets are available in standard and special sizes made to your specifications. Available in bolted or all welded construction. Write today for STEARNS Lifting Magnet literature.

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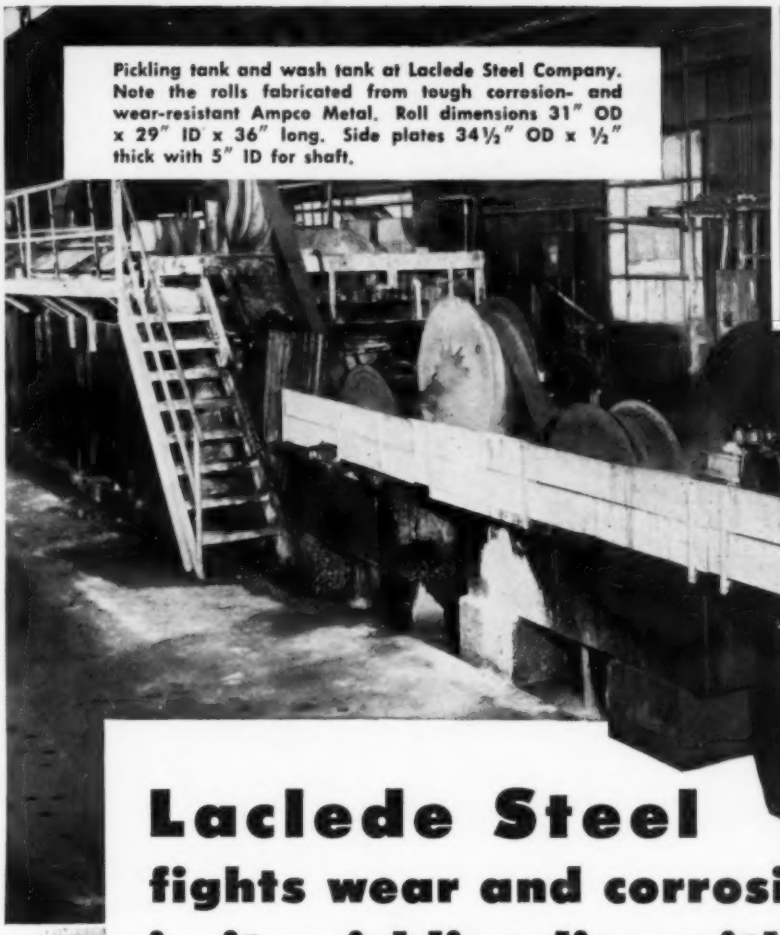
MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC.

681 SOUTH 28TH STREET, MILWAUKEE 46, WIS.



Pickling tank and wash tank at Laclede Steel Company. Note the rolls fabricated from tough corrosion- and wear-resistant Ampco Metal. Roll dimensions 31" OD x 29" ID x 36" long. Side plates 34½" OD x ½" thick with 5" ID for shaft.

Here's another roll used at Laclede. Fabricated from money-saving Ampco Metal, it handles six strips at a time.

Laclede Steel
fights wear and corrosion in its pickling line with
AMPCO METAL*

...keeps production up...costs down

Steel companies throughout the country are faced with terrific production problems. Laclede Steel Company, St. Louis, like so many others, found one answer in Ampco Metal.

Shown here is their pickling operation. The tank carries a 12% sulphuric acid solution at 200°F. The strip enters the tank and goes through the entire process via wear- and corrosion-resistant Ampco Metal rollers.

The rollers and side plates are fabricated from Ampco Grade 8 plate. Shafts and nuts are made from extruded Ampco Grade 15.

But resistance to corrosion in pickling service isn't the only important feature of Ampco Metal. It also resists wear, shock, impact. That's why so many mills use Ampco Metal screw-down nuts, slippers, wear plates, flash-welder dies.

If you have a corrosion problem or a wear problem, it pays to investigate the advantages of Ampco Metal. See your nearby Ampco field engineer or write us for details.

AMPCO METAL, INC.
Dept. IS-4 • MILWAUKEE 46, WISCONSIN
West Coast Plant • Burbank, California

*Reg. U. S. Pat. Off., Ampco Metal, Inc., Milwaukee, Wis.

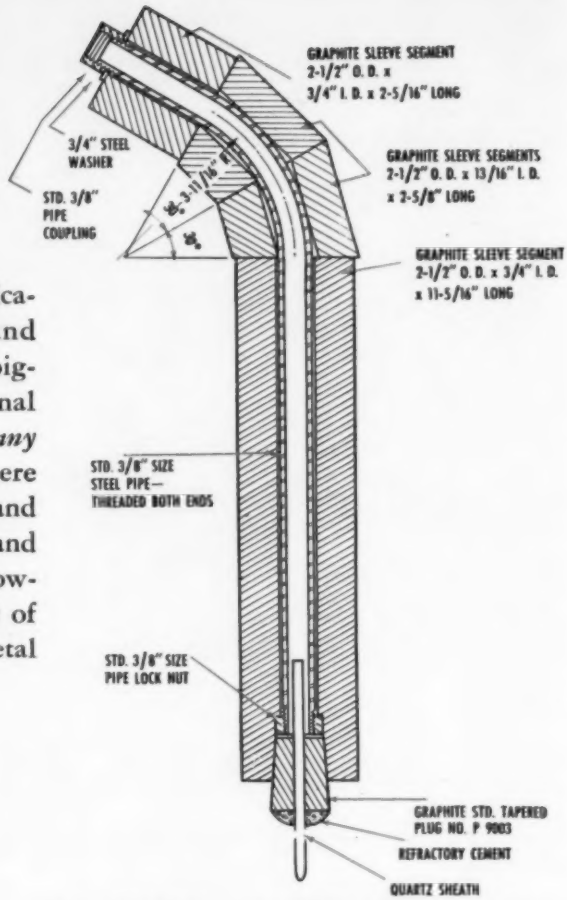
AMPCO®

G-11

In Furnace and Foundry...

These SMALL PARTS do a BIG JOB

● High temperature applications of "National" Carbon and Graphite are not limited to big-tonnage items. A part of National Carbon's service is to develop *any* application, however small, where the unique properties of carbon and graphite assure a convenience and economy to the user. In the following two instances, a few *pounds* of graphite serve literally *tons* of metal . . . efficiently and at a saving.


GRAPHITE SLEEVE SEGMENT
2-1/2" O. D. x
3/4" I. D. x 2-5/16" LONG
3/4" STEEL WASHER
STD. 3/8" PIPE COUPLING
GRAPHITE SLEEVE SEGMENTS
2-1/2" O. D. x 13/16" I. D.
x 2-5/8" LONG
GRAPHITE SLEEVE SEGMENT
2-1/2" O. D. x 3/4" I. D.
x 11-5/16" LONG
STD. 3/8" SIZE STEEL PIPE—
THREADED BOTH ENDS
STD. 3/8" SIZE PIPE LOCK NUT
GRAPHITE STD. TAPERED PLUG NO. P 9003
REFRACTORY CEMENT
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"NATIONAL" GRAPHITE FLUXING TUBES

Can't be equalled by any other material for the introduction of purifying gases into molten metal. Graphite can't melt in the bath, can't contaminate the metal. Its low coefficient of expansion prevents cracking and spalling. Metal and dross do not adhere tightly to it. And whatever gases are used, graphite will not corrode.

"NATIONAL" GRAPHITE-SHEATHED THERMOCOUPLE ASSEMBLY (Typical)

Only graphite could provide the degree of low-cost, trouble-free protection required by thermocouple assemblies of this type for the immersion method of measuring open hearth and electric furnace bath temperatures. Reclamation and maintenance for re-use are simple, quick, and economical. Molten metal won't stick to the graphite parts and they're immune to thermal shock.

HERE'S HOW TO LICK HY HEET

National Carbon Company
30 E. 42nd Street
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PLEASE SEND INFORMATION ON:

☐ Thermocouple Sheath Parts ☐ Fluxing Tubes

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. . . mark phenomenal acceptance of "EVEREADY" No. 1050 Industrial Flashlight Batteries by a broad cross-section of industry. Delivering twice the usable light of any battery we've ever made before, it will not swell, stick or jam in the flashlight . . . has no metal can to leak or corrode.

BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • SKIMMER BLOCKS • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS • TANK HEATERS

Personnel News...

Harry L. Jenter has been appointed to the position of district manager of operations for the Cleveland, Ohio, district of American Steel & Wire Division of U. S. Steel Corp. Mr. Jenter, who has been assistant district manager, succeeds **Albert J. Hoyt,** who has retired. In his new post, Mr. Jenter will be concerned with the operations of wire division facilities in Cleveland, including Cuyahoga Works, American Works, Central Furnaces and Docks and Coke Works, and Newburgh Works.

Richard R. Snow has been named assistant to vice president of operations of American Steel and Wire Division, U. S. Steel Corp., with headquarters in Cleveland, Ohio, and **John P. Debri** has been appointed general superintendent of the wire division's Joliet, Ill. plant. Mr. Debri succeeds Mr. Snow who leaves his Joliet post to succeed **Burton H. Gedge** who is retiring after 42 years of service. In his new post Mr. Snow is responsible in a staff capacity for American Steel & Wire "hot" operations in its 14 mills in nine cities spread from Duluth, Minn. to Trenton, N.J. This includes open hearths, rolling mills and rod mills.

A. B. Fisher, Jr. has been named assistant general manager of the Engineering and Construction Division of Koppers Co., Inc., Pittsburgh, Pa. **G. P. Wilson, Jr.** will fill the post of manager of control for the Engineering and Construction Division. In this capacity, Mr. Wilson will supervise all finance and budgetary functions for the division. Mr. Wilson has been on leave from Koppers since 1950 when he was appointed director of the coke division of the Solid Fuels Administration in the United States Department of Interior. He resigned this post to return to Koppers December 31, 1952. In 1926 Mr. Fisher joined Koppers as a draftsman and has seen continuous service with the company since then. Over a twenty year period, Mr. Fisher was employed in various sections of the engineering department of Engineering and Construction Division and later was a contract engineer for the division. In 1948, he was promoted to chief engineer in the Engineering and Construction Division and, in 1952, he was named to the position of executive assistant of that division.

James McClintock has been named superintendent of Republic Steel Corp.'s electric weld tube mills at Youngstown, Ohio. Mr. McClintock had been serving as assistant superintendent of the continuous weld tube mills. **James W. Maughan** was appointed assistant superintendent of the electric weld tube mills. **Edward Weden, Jr.** was made superintendent of the continuous weld tube mills. Mr. Weden had been serving as assistant superintendent since October 1951. **Eugene L. Kline** has been named assistant superintendent of the continuous weld tube mills. Previously, Mr. Kline had been general foreman for finishing. **Robert C. Johnston** has been appointed superintendent of the bessemer converters. Mr. Johnston has been assistant superintendent of this department since June 1951. **John F. Beale** is now assistant superintendent of the bessemer converters.

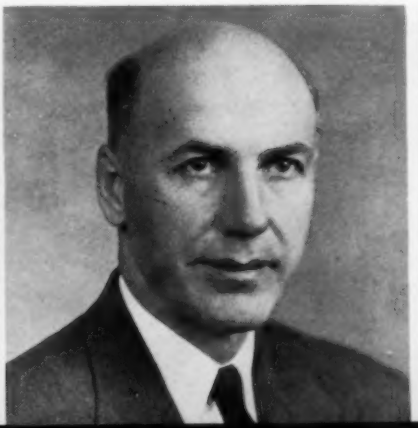
Edward N. Fleming was appointed superintendent of maintenance of the Claymont, Del., plant of Colorado Fuel and Iron Corp. Mr. Fleming had been associated with the Claymont plant in the capacity of plant engineer since 1949 and prior to that time served as an electrical engineer with U. S. Steel Corp., chief electrician with Standard Steel Spring Co., and maintenance foreman with Allegheny Ludlum Steel Corp.

R. J. Sprott has been named assistant production manager of the Engineering and Construction Division, Koppers Co., Inc., Pittsburgh, Pa. In addition **C. S. Carden** was named chief engineer, **A. D. L. Orefice** as assistant chief engineer, and **C. G. Barnett** as manager of the by-product section of the division's engineering department. Mr. Sprott has been chief engineer since 1951, and Mr. Carden, since 1951, was assistant chief engineer. Mr. Orefice has been successively assistant manager of the by-product section, contract engineer, and, since 1951, manager of by-product section.

Robert G. Morgan was named district manager of Moline, Ill., office of Timken Roller Bearing Co., and **Robert L. Williams** to the post of district manager, St. Thomas, Ontario, Canada, office.

HARRY L. JENTER

RICHARD R. SNOW



JOHN P. DEBRI

A. B. FISHER, JR.

E. H. Heckett was elected chairman of the board for Harrisburg Steel Corp., Harrisburg, Pa. **J. T. Simpson** was named president; **H. M. Reeser** and **D. M. Horner,** vice presidents; and **E. L. Martin** was appointed treasurer.

Joseph J. Just was made assistant to general superintendent of the Donora, Pa., steel and wire works of American Steel and Wire Division, U. S. Steel Corp. He

JOSEPH J. JUST

succeeds **Charles Witherspoon** who is retiring March 31 after 37 years' service. At the same time he announced the advancement of **John T. McHugh** as division superintendent, wire and wire products, the position formerly

JOHN T. McHUGH

held by Mr. Just. Prior to his present advancement Mr. McHugh was department superintendent, nail mill, the position he received in January, 1949.

A. C. Brown, Jr., regional manager of the Air Reduction Sales Co. has been appointed general sales manager. Mr. Brown, who has been located in Pittsburgh, Pa., will have his headquarters at 60 East 42nd Street, New York, N. Y. **J. H. Keeney,** administrative assistant in Pittsburgh, succeeds Mr. Brown as regional manager. **J. H. Hart,** Detroit, Mich., district manager succeeds Mr. Keeney. **R. A. Jamieson,** assistant sales manager, Detroit, succeeds Mr. Hart.

H. R. Ryan, superintendent of the bessemer and open hearth department at the Youngstown Sheet and Tube Co.'s Campbell plant at Youngstown, Ohio, has been transferred to Indiana Harbor, Ind., works as superintendent of the company's new No. 2 open hearth department. **Robert Frushour,** formerly with the Edgar Thomson works of United States Steel Corp., has joined the company, succeeding Mr. Ryan as superintendent of the bessemer and open hearth department at Campbell.

Robert McConnachie was appointed assistant chief combustion engineer for the Chicago, Ill., district of Republic Steel Corp. Since 1946, Mr. McConnachie has been serving as combustion engineer.

Andrew F. Kritscher was appointed assistant chief engineer-process development of National Tube Division, U. S. Steel Corp., Pittsburgh, Pa. Mr. Kritscher has been development engineer since 1951.

Kenneth Tutein and **George Bickell** have formed a new company known as Tutein and Bickell, 429 Broadway, McKees Rocks, Pa. Both Mr. Tutein and Mr.

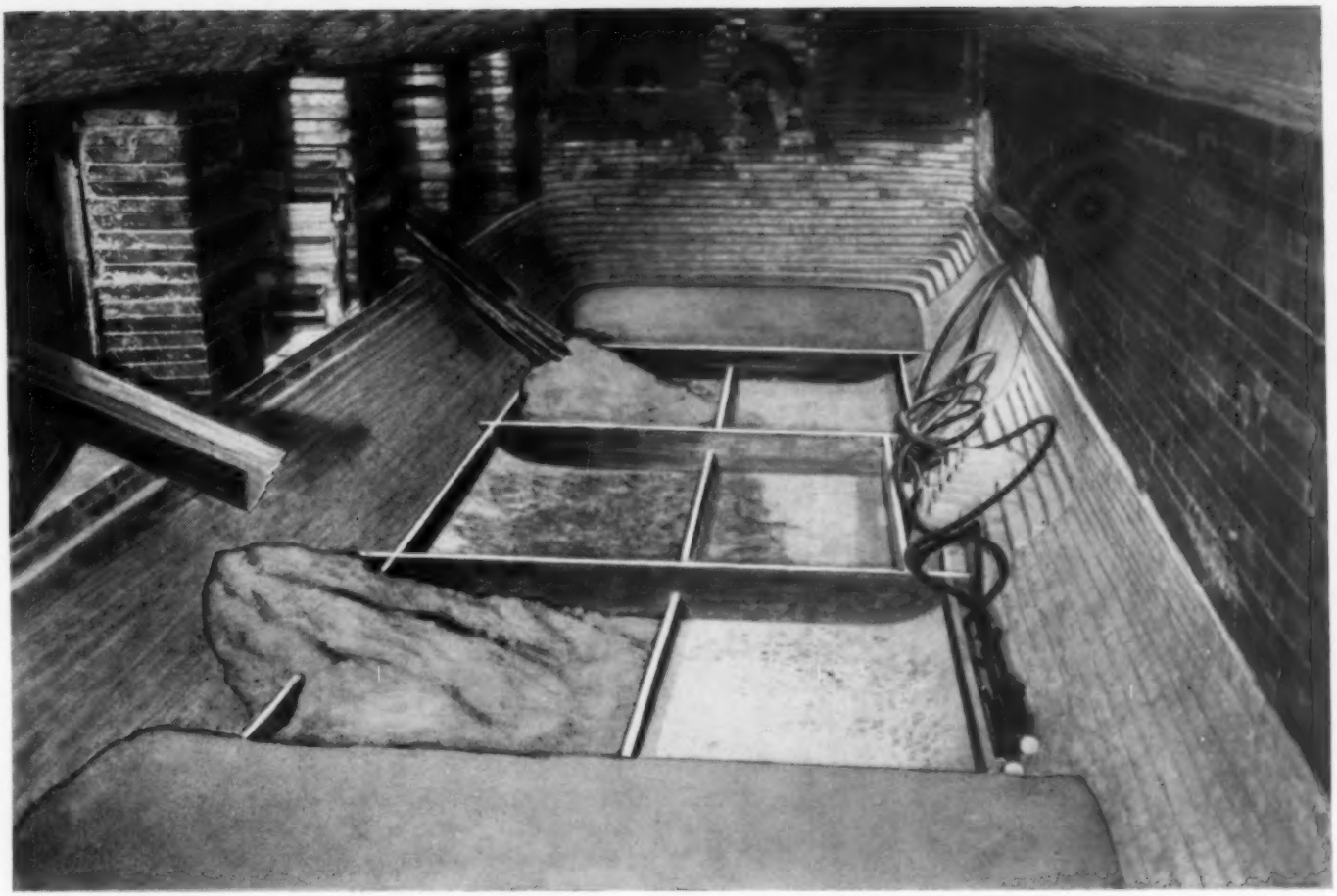
KENNETH TUTEIN

Bickell have been serving the Pittsburgh area for 15 years in the industrial heating and air conditioning field. Their new organization will continue to serve these fields.

William F. Alexander will assume the post of assistant manager of the Procurement department of Koppers Co., Inc., Since 1948 Mr. Alexander has been responsible for purchasing of materials for the many coke oven and steel plant construction projects of Koppers Engineering and Construction Division.

Frank R. Romeo was named superintendent of the roll hardening department at Midvale Co., Nicetown, Philadelphia, Pa. Mr. Romeo has been at Midvale since 1949.

C. F. Anderson has been named vice president in charge of operations for Page-Hersey Tubes, Ltd., of Welland, Ontario, Canada. **C. W. Morehead** has been



OPEN HEARTH SHOWN DURING A SPECIAL BOTTOM INSTALLATION OF PERMANENTE 165 RAMMING MIX

INCREASE YOUR OPEN HEARTH PRODUCTION

WITH PERMANENTE 165 RAMMING MIX!

THE superiority of Permanente 165 ramming mix for open hearth bottoms is proved by continuing reports from many of the country's leading steel mills.

Many furnaces are "tripling"... original tap holes are lasting up to 80 heats without repiping ... production records are being broken, with extra tonnage every hour.

Chances are that the proved superiority of a Permanente 165 bottom, based on records of scores of furnaces, can boost *your* open hearth production well above current rates.

SEND FOR BOOKLET giving *all* the important advantages of Permanente 165 and the companion material, Permanente 84. Upon request, your Kaiser refractory engineer will promptly offer you research, design and installation service to help you obtain more steel tonnage per year, at lower bottom cost per ton. Call or write principal sales offices: *Chemical Division*, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, Calif. First National Tower, Akron 8, Ohio.

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Pioneers in Modern Basic Refractories

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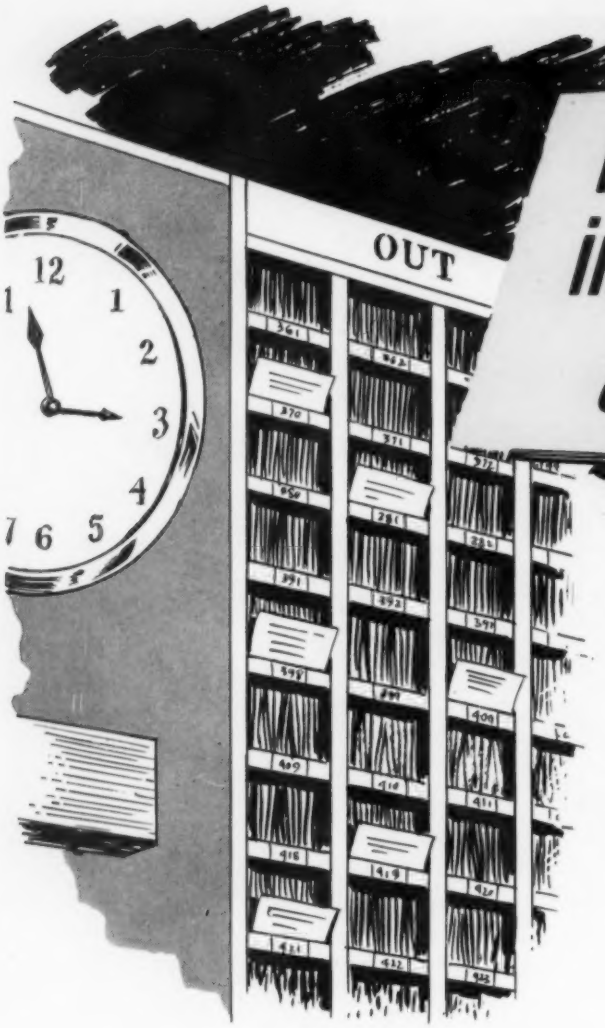


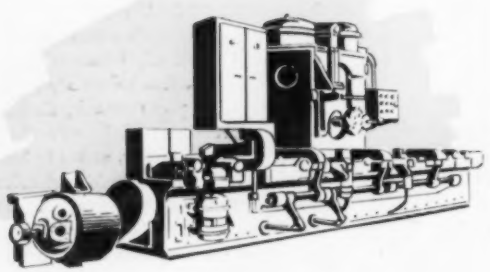
keep their cards in the racks and active!

ABSENTEEISM AND LABOR TURNOVER IN BILLETSHED EFFECTIVELY SOLVED BY BONNOT BILLETEER

It replaces dangerous, ear-splitting, nerve-wracking drudgery with smooth, precision mechanical "chipping" under safe and easy, finger-touch control.

"Billeteering" ends absenteeism due to "nerves," fatigue and job-dislike. It puts billetshed work on a par with other "operator" jobs in the mill . . . makes the billetshed a preferred place to work.

What's more... the Bonnot Billeteer provides a steady, dependable supply of conditioned billets, permitting reduction of inventories and eliminating disruption of rolling schedules. Chips are 100% recoverable . . . excessive re-melting is eliminated . . . the job is done better, 10 times faster AND AT A SAVING OF 56%.



If labor-force stability, dependable scheduling and lower costs are important to you, it is important that you have all the data on "Bonnot Billeteering."

Engineered For Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Also Manufacturers of — SAWING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
CRUSHING • DUST PUG MILLS • SINTER PLANT PUG MILLS

appointed to the position of general works manager, formerly held by Mr. Anderson. **R. E. Reese** has been named to fill the position of assistant general works manager vacated by Mr. Morehead.

M. Merle Harrod has been elected president of Wapakoneta Machine Co., Wapakoneta, Ohio, following the recent death of **Carl D. Fischer, Jr.** Mr. Harrod was

M. MERLE HARROD

formerly vice president of the company. Other executive officers are **Lucas C. Fischer,** vice president; and **Emil J. Fischer,** secretary-treasurer.

Samuel J. Mabry has been appointed Atlanta, Ga., district manager, industrial products division of Goodyear Tire & Rubber Co. Mr. Mabry, who has been an industrial products representative for Goodyear at Los Angeles since 1948, replaces **John E. Ragan,** deceased. **R. B. Warren** has been named manager of Goodyear's industrial products departments at Akron, Ohio. **L. W. Adams** has been promoted to Mr. Warren's former post as southern sales manager, industrial products division.

Howard Winterson has been appointed director of industrial relations of Blaw-Knox Co., Pittsburgh, Pa.

Robert D. Briggs has been placed in charge of sales and service in the Cincinnati territory for C & D Batteries, Inc. Mr. Briggs will maintain headquarters at 7446 Vine Street, Cincinnati 16, Ohio.

George F. Burditt has been appointed district manager of the Pittsburgh office of American Wheelabrator and Equipment Corp. at 91 Central Square, Pittsburgh 28, Pa. Mr. Burditt has been serving as district manager at Greensboro, N. C.

S. C. Faddis, former works metallurgist at Pittsburgh, Pa., works, of Jones & Laughlin Steel Corp., has been named assistant works manager of the Cleveland, Ohio works division, succeeding **J. M. McColloch,** who has retired. **K. S. Loofboro,** acting assistant superintendent of blast furnaces of the Aliquippa, Pa., works, was named superintendent of blast furnaces, coke works, and dock at Cleveland works.

John A. Deitrich was elected president of Hind Steel Co., Inc., Union, N. J. Mr. Deitrich formerly was divisional general manager of the Carpenter Steel Co.

Murray E. Rhue, director of manufacturing, for Morgan Engineering Co., Alliance, Ohio, has resigned and will be succeeded by **Harvey W. Bush,** recently general manager of the Rack Engineering Co. of Connellsville, Pa.

W. F. Huntley, was named superintendent of the blast furnace department at the Aliquippa, Pa., works of Jones & Laughlin Steel Corp. Mr. Huntley succeeds **Elmer H. Riddle,** veteran blast furnace operator, who has retired. Mr. Huntley was former assistant superintendent of the department. **A. T. Sadler, Jr.,** succeeds Mr. Huntley as assistant superintendent of the blast furnace department.

Thomas C. Jackson was named chief engineer of the Michigan Limestone Division of U. S. Steel Corp., Detroit, Mich. Mr. Jackson succeeds **Robert H. Lucas,** who becomes assistant to president of U. S. Steel's Pittsburgh Steamship Division, with headquarters in Cleveland, Ohio.

Si Feigenbaum, has been named works metallurgist of the Pittsburgh, Pa., works division of Jones & Laughlin Steel Corp. He succeeds **S. C. Faddis,** who has been transferred to the Cleveland, Ohio works division.

P. J. Castora was named vice president in charge of engineering and sales for Pittsburgh Engineering and Machine Co., Glassport, Pa. Mr. Castora was formerly staff engineer with the Aluminum Co. of America, Pittsburgh, Pa. Prior to that, he was associated with E. W. Bliss Co., Salem, Ohio, and United Engineering and Foundry Co. in a sales and engineering capacity.

P. J. CASTORA

G. W. Linkhauer was appointed vice president in charge of operations. Mr. Linkhauer was formerly associated with United States Steel Corp., Lewis Foundry & Machine Division of Blaw-Knox Co., United Engineering and Foundry Co. in various engineering, manufacturing and plant operating capacities.

George I. Reynolds, Jr. was named assistant director of market development, U. S. Steel Corp., Pittsburgh, Pa. Mr. Reynolds has been the assistant manager, product section, in the company's commercial research division.

Harold E. Rowen, vice president and general manager of Sintering Machinery Corp., Netcong, N. J., has assumed the additional responsibility of directing the sales of the company's metallurgical division.

Burton R. Buck was named works manager of Electro Metallurgical Co., a division of Union Carbide and Carbon Corp. Mr. Buck has been assistant works manager since January, 1951, and has been located in the general offices in New York, N. Y.

James R. Cummings has been made director of engineering and sales for Stamco, Inc. Before coming with Stamco, he was with the Reynolds Metals Co. in Richmond, Va., Tennessee Coal Iron & Railroad, division of U. S. Steel Corp., Birmingham, Ala. **William Bailey, III** is now in sales and services for Stamco, Inc. Prior to coming with them in 1950, he was associated with Reynolds Alloys in Alabama.

William C. Ridge has been appointed works manager in charge of the manufacturing operation of the Trenton and Roebling, N. J., plants of the John A. Roebling's Sons Corp. The John A. Roebling's Sons Corp. is a wholly-owned subsidiary of Colorado Fuel and Iron

WILLIAM C. RIDGE

Corp. Mr. Ridge succeeds to the duties formerly performed by **J. D. Thompson,** who has resigned to accept another position. Since 1950, Mr. Ridge has directed the operations of the electric wire division as manufacturing manager.

Harry P. Neher, Jr., has been appointed assistant manager of the Central staff sales department of Koppers Co., Inc., Pittsburgh, Pa. **Thomas H. Cable** was named manager, sales methods section, a post formerly held by Mr. Neher, and **George C. Miller** becomes manager, international product sales section, succeeding Mr. Cable. Mr. Neher takes the position made vacant by the recent appointment of **Donald MacArthur** as manager of Koppers' Washington office.

Albert H. Clem has been appointed general sales manager of the Pennsylvania Salt Manufacturing Co., Philadelphia, Pa., filling the position left vacant by the recent death of **Russell S. Roeller.** Before this appointment Mr. Clem was assistant general sales manager.

Ellis J. O'Brien has been appointed chief development engineer of Heyl & Patterson, Inc., Pittsburgh,

ELLIS J. O'BRIEN

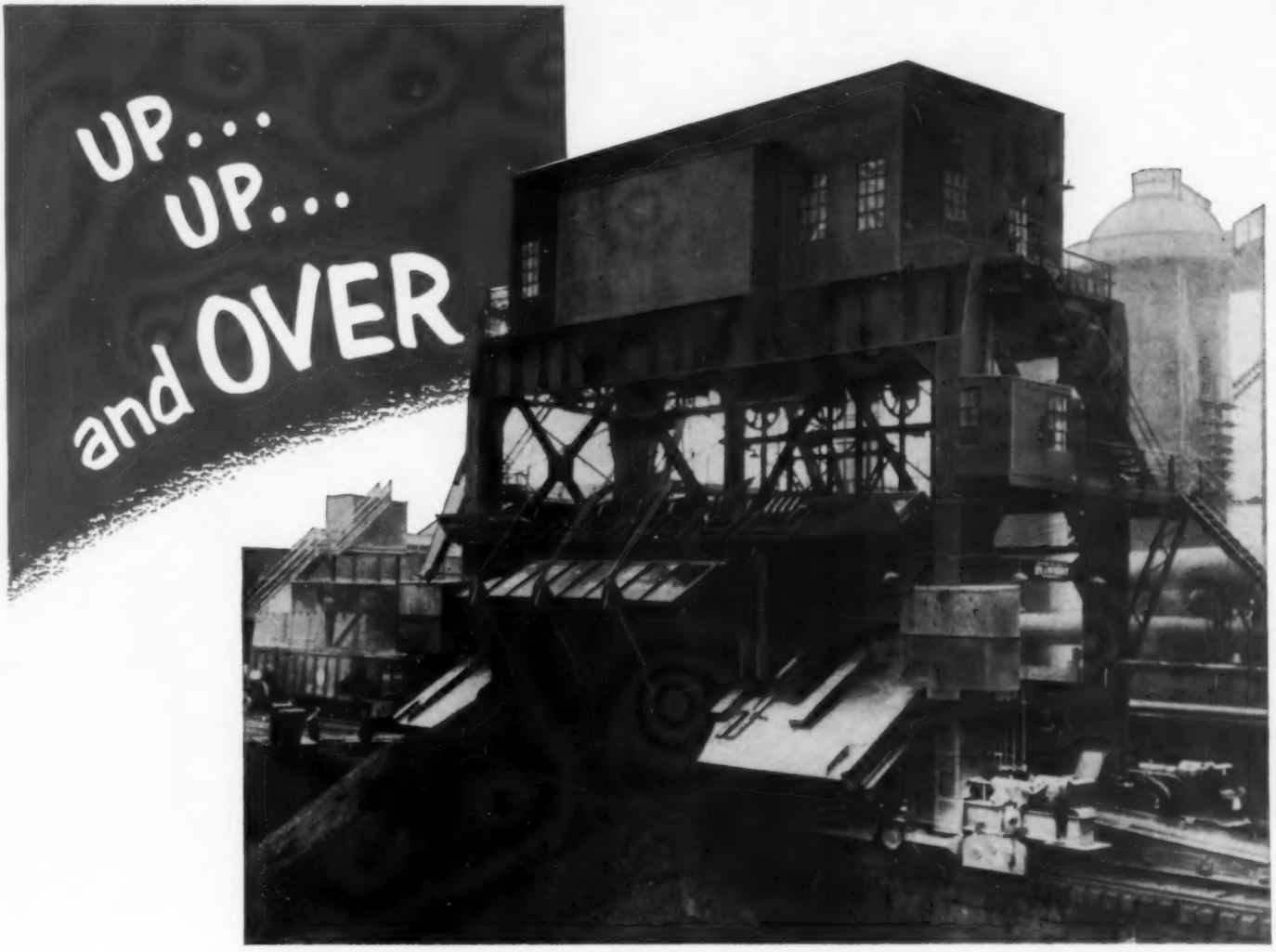
Pa. In this position Mr. O'Brien will direct the activities of the company's research and development department.

L. E. West has been named general sales engineer for Dowell, Inc. Mr. West will be located at the company's headquarters in Tulsa, Okla. His responsibilities will include customer relationship and sales promotion in all Dowell areas where the company offers its chemical maintenance service except the Atlantic coast territory, which will continue to be under **L. B. Wilson,** operating out of Dowell's New York office.

Sam R. Watkins was named executive vice president of National Bearing Division of American Brake Shoe Co. Since 1951, Mr. Watkins had been serving as president of Brake Shoe and Castings Division. Mr. Watkins will transfer to the National Bearing Division headquarters in St. Louis, Mo.

John A. Stefon, Jr. has been transferred to Chicago, Ill., as office and warehouse manager of the Chicago district office of Rockbestos Products Corp., New Haven, Conn. Mr. Stefon has been priorities adviser in the New Haven sales office.

John F. Ducey, Jr. has been named vice president of the Brake Shoe and Casting Division, American Brake Shoe Co. **George E. Anne** becomes assistant vice president and **Daniel J. Wagner** is distrist sales manager. Mr. Ducey is located at the San Francisco, Calif., office.



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At a large Western Pennsylvania steel mill this Heyl & Patterson Traveling Car Dumper has been efficiently unloading iron ore for the past 10 years.

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Designed, fabricated and erected by Heyl & Patterson, this installation reflects the ability of H & P to do the "whole job" from beginning to end . . . from original design to successful operation.

When your problem is concerned with the handling or transportation of ore, coal, slag, limestone or other bulk materials . . . call on Heyl & Patterson, specialists in the design, fabrication and erection of Heavy Bulk Materials Handling Equipment since 1887.

- Ore Bridges
- Railroad Car Dumpers
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- Cyclone Thickeners
- Coal and Coke Handling Equipment
- Coal Crushers
- Coal Storage Bridges

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Heavy Bulk Materials Handling Equipment
All The Way from Design to Erection

Mr. Anne is located at the Philadelphia, Pa., office, and Mr. Wagner is located at Chicago, Ill.

Charles J. Guimbarda was made a design engineer for Laclede Arch Co., St. Louis, Mo. Mr. Guimbarda was formerly project engineer for the U. S. Navy's jet engine plant in Detroit, Mich.

Frank Purnell, for more than 23 years executive officer of Youngstown Sheet and Tube Co., Youngstown, Ohio, plans to retire in April after 51 years in the steel industry. He has been chairman of the board for three years. Mr. Purnell joined Youngstown Sheet and Tube Co. March 17, 1902 as a hall boy. He worked up through various jobs in the order, accounting and sales department; was with the War Industries Board during World War I and returned to the company in 1923 as vice president. He was elected assistant president five years later. On January 1, 1930 he was elected president of the company and became its chairman in 1950.

V. P. Rumely was appointed senior vice president, manufacturing, and **L. N. Blugerman** as vice president of Crane Co., Chicago, Ill. Mr. Blugerman will have charge of production in the company's plants at Chi-

V. P. RUMELY

cago and Chattanooga, Tenn., reporting to Mr. Rumely, who, in addition to supervision of the Chicago works and Chattanooga division, will coordinate manufacturing operations in all the plants of the company's subsidiaries.

Byron L. Foster has been elected president of L. B. Foster Co., Pittsburgh, Pa. He succeeds **Lee. B. Foster,** who becomes chairman of the board of directors.

Thomas Bruce Carpenter, superintendent of the open hearth department at the Brier Hill works of Youngstown Sheet and Tube Co., Youngstown, Ohio, has been named general superintendent at Brier Hill, succeeding **D. W. Lloyd** who was recently moved to the Indiana Harbor, Ind., works as general superintendent. **James W. Kirkpatrick** was made chief metallurgist in the Youngstown district succeeding Mr. Carpenter as superintendent of the Brier Hill open hearth department.**Ernest B. Plott,** steel plant metallurgist, becomes chief metallurgist in the Youngstown district, succeeding Mr. Kirkpatrick.

Homer W. Sussman was named general sales manager of Columbia Electric Manufacturing Co., Cleveland, Ohio.

Mr. Sussman joined Columbia as a student engineer in 1935, and has held various positions in the engineer-

HOMER W. SUSSMAN

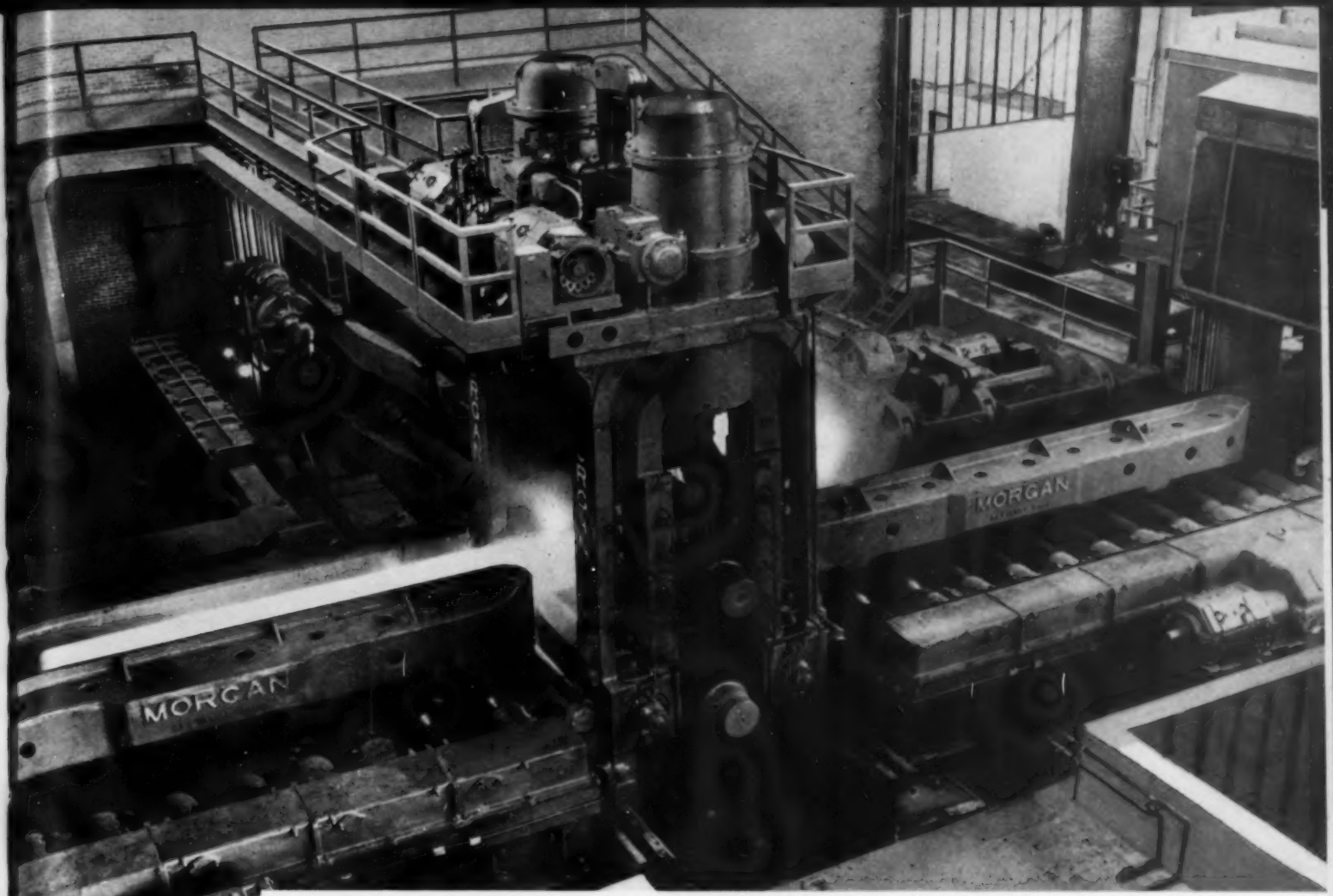
ing and sales departments. In his new position he will assume responsibility for an expanded sales program covering the company's line of alternating and direct current generators, low voltage generators and motor generator sets, synchronous motors, tank rheostats and electrical instruments.

Fred B. Shew has been named sales manager of the bucket department of Wellman Engineering Co. Mr. Shew has been transferred to the home offices in Cleve-

FRED B. SHEW

land, Ohio, from the Chicago, Ill., office of Wellman where he served as district manager. Previously he served as district manager of the New York office.

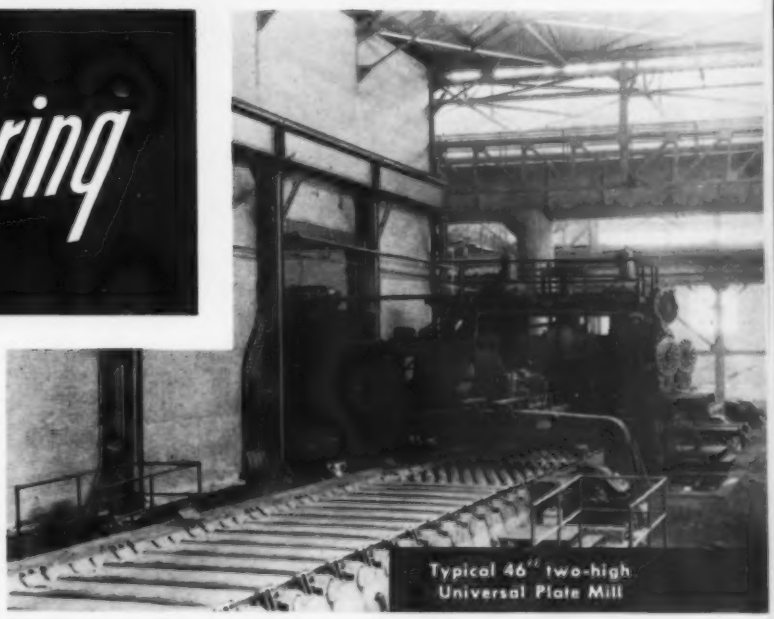
James W. Bennett was named as design engineer for Laclede Arch Co., St. Louis, Mo. Mr. Bennett was previously sales manager for Penn Industrial Instrument Co.



A Modern 40" two-high Blooming Mill with Twin Motor Drive

BUILT BY MORGAN Engineering

26" Structural Mill with Traveling Tilting Tables



Typical 46" two-high Universal Plate Mill

MILL BUILDERS AS WELL AS CRANE BUILDERS

● For over a half century The Morgan Engineering Co. has designed and built heavy duty Mills and their Auxiliary Equipment for the steel industry in many parts of the world. Pictured here are a few typical Morgan installations in use. *Your inquiries will be appreciated. Ask for Bulletin No. 16-A.*

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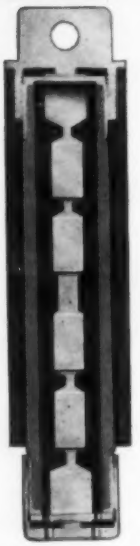
Oil Immersed

SAFETY LINE DISCONNECT SWITCHES

30 - 60 - 100 - 200 - 400 - amp. available for 250 and 600 volt service



Cutaway view (right) shows unique design of Rowan low-Voltage AIR-SEAL fuse for use under oil.

Rowan Type 620-A Line of Safety Disconnect Switches are designed to provide dependable service in all locations especially where the atmosphere is corrosive or charged with semi-hazardous dust or vapors such as chemical plants, oil refineries, steel, and cement mills. A few of the oustanding features of these switches include:

1. Completely oil immersed. 2. Equipped with Rowan time-tested AIR-SEAL fuses. 3. Disconnect switch of the quick-acting contactor type with renewable contacts. 4. Top and tank are mechanically interlocked with the disconnect switch to prevent lowering of tank when switch is in operating position or closing of switch when tank is lowered. 5. Provision for padlocking disconnect switch in the OFF position. 6. Enclosing case is weather resisting. 7. Unique arrangement for lowering tank for inspection without removing tank from unit.

Enclosures are NEMA Type XI: NEMA Type VIII enclosures are available. Complete information available from Rowan representatives in principal cities of the United States.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

W. A. Morris, Jr., formerly director of purchases of Jones and Laughlin Steel Corp., Pittsburgh, Pa., was named to the new post of vice president-purchases, and was appointed to the management committee. **J. W. Lindsey,** formerly assistant director of purchases, was named general purchasing agent, **A. N. Johnston,** formerly purchasing agent, was named assistant to the vice president-purchases; and **C. L. Brinker,** formerly assistant purchasing agent, was made assistant general purchasing agent-raw materials. **H. W. Graham,** formerly vice president-technology, becomes vice president-research. He will direct all research for J&L and its subsidiaries and will serve as technical consultant with regard to the Corporation's operations generally. **D. T. Rogers,** formerly assistant director of technology, becomes director-techical services.

William Rodgers of Pittsburgh has been named general sales manager of Blaw-Knox Co. Mr. Rodgers will co-ordinate sales activities for all divisions of the company, as well as assist in developing sales objectives, policies, and programs. Mr. Rodgers for many years was identified with McCrady-Rodgers Co. of Pittsburgh, where he served as vice president and a director. He resigned in 1948 to devote himself to other interests. In recent years, he has been president of Moore-Flesher

WILLIAM RODGERS

Hauling Co., Inc. and of Rodmor Hauling Co., both of Pittsburgh; and president of Lake Equipment Corp. of Erie, Pa. He is also a director of Granite City Steel Co.

Edward A. Macke, Jr. joined the S. H. Bell Co. in 1952 and is selling metallurgical products produced by the Tennessee Products & Chemical Corp. Mr. Macke was formerly maintenance metallurgist, Pittsburgh, Pa. works, Jones & Laughlin Steel Corp.

Richard H. Oberholtzer was named manager of the Milwaukee district of Kennametal, Inc. with headquarters at 744 N. Fourth Street, Milwaukee, effective May 1, 1953. Mr. Oberholtzer has been working out of Kennametal's Detroit office since 1946. Other Kennametal appointments are: **Leonard Arnold** as a representative in the Syracuse, N. Y. area; **James Denial** as representative in Elmira, N. Y.; **Kenneth Hoffman** as a service engineer in the Chicago, Ill., area; **Andrew Horvath** as a service representative in the middle Atlantic district; **Robert Schwing** as a service engineer in the Middle Atlantic district; **George R. Sundell** as a service engineer in the Pittsburgh, Pa., area; and, **Carl E. Widen** as a service engineer in the Chicago area.

Harry E. Beane has been appointed vice president of sales of Bristol Co., Waterbury, Conn. Since 1947, Mr. Beane had been serving as general sales manager.

HARRY E. BEANE

R. B. Waters was named sales engineer in Ohio for Thompson & Co., Oakmont, Pa. In his new capacity, with headquarters in Cleveland, Mr. Waters will sell and service the complete Thompson line of industrial coatings, including electrical insulation varnishes and the Vinsynite series of metal pretreatments.

Charles T. McClure, formerly with Youngstown Steel Products Co. has joined Youngstown Sheet and Tube Co. as superintendent of field engineers, tube division. He will work out of the general superintendent's office of the company's tube division.

A. F. Wiest has been placed in charge of all manufacturing operations for the Alloy Tube Division of Carpenter Steel Co. at Union, N. J. Mr. Wiest succeeds John A. Dietrich who recently resigned.

Charles T. White, Jr., formerly belting sales engineer, has been appointed Pittsburgh, Pa., district manager, industrial products division, Goodyear Tire & Rubber Co.

Henry F. Arndt of the Detroit Electric Furnace Division, Kuhlman Electric Co., Detroit, Mich., has been named chief engineer of the division to replace **Charles V. Kilburn** who resigned last month to join the Essex Wire Corp.

Robert E. Gentz has been appointed director of management development, a new position, at Inland Steel Co.'s Indiana Harbor, Ind., works. Mr. Gentz will report directly to the vice president in charge of steel

manufacturing. Replacing Mr. Gentz as superintendent of the sheet and galvanizing department will be **Robert W. Rost,** who has been transferred from the Jersey City, N. J. plant of Inland Steel Container Division. Prior to his New Jersey assignment, Rost was assistant superintendent of the sheet and galvanizing department at Indiana Harbor. **Herbert C. Lieberum** will become superintendent of labor relations and **Thomas G. Cure** will take over Mr. Lieberum's position as assistant superintendent.

Robert Courtney has opened an office in Milwaukee, Wis., under the name of Batteree Co., located at 5625 W. Wells Street. He will offer sales and service facilities for all types of C & D Batteries, covering the states of Minnesota, Wisconsin and the upper Michigan peninsula.

C. G. Wallis, former manager of the headquarters manufacturing department of Westinghouse Electric Corp., Pittsburgh, Pa., will now serve as assistant to the vice president. Other executive appointments include **L. S. Houk,** as director of works engineering; **N. H. King** and **R. I. Wilson,** director and assistant director, respectively, of production and inventory control; **G. C. Moore,** director of plant industrial engineering; **V. D. Mack,** supervisor of manufacturing student training; and **Joseph Manuele,** director of quality control.

Joseph Player was elected president of Romulus Tool and Engineering, a newly organized firm located at 36051 Goddard, Romulus, Mich. **Edward Halik** is associated with Mr. Player. Mr. Player and Mr. Halik were former employees of Turchan Follower Machine Co.

Max M. Muller and **Harvey N. Barrett, Jr.,** have been elected vice presidents of Basic Refractories, Inc., Cleveland, Ohio. Mr. Muller will direct operations and engineering and Mr. Barrett will take charge of sales activities.

HARVEY N. BARRETT, JR.

A. S. Payne has been appointed director of industrial relations of Air Reduction Co., Inc., New York, N. Y. Prior to this promotion, Mr. Payne was vice president of the Ohio Chemical and Surgical Equipment Co. division located in Madison, Wisc.

R. D. Satterley was named manager of Inland Steel Co.'s iron ore mines and **Howard M. Graff** was made assistant manager. Mr. Satterley has been general superintendent of iron mines since 1946. Mr. Graff has been located at the iron mines operation since July 1950 as assistant general superintendent.

Obituaries

Robert French Chaffin, 66, chief electrical engineer for Crucible Steel Co. of America, died March 9. Mr. Chaffin had been associated with Crucible since 1912.

Walter W. Patnoe, 65, chief engineer for Basic Refractories, Inc., Cleveland, Ohio, died March 4.

Robert H. Gardner, 58, general sales manager for A. M. Byers Co., Pittsburgh, Pa., died March 9.

Rudolf Nagel, 63, chief engineer of the heavy materials handling division of Heyl & Patterson, Inc., died in Pittsburgh, Pa. Mr. Nagel had been chief engineer of Heyl & Patterson for the past eight years and an employee of the company since 1916.

B. H. Lawrence, 70, who retired as vice president of engineering, U. S. Steel Corp., in 1948 died March 25. Mr. Lawrence served with the corporation at Waukegan, Ill., Chicago, Ill., Cleveland, Ohio, Worcester, Mass., and in Pittsburgh, Pa.

Frederick Donald Schreiber, 62, manager of the coal chemicals division of Pittsburgh Coke & Chemical Co., Pittsburgh, Pa., died March 22 in Ocala, Fla.

Andrew P. Carstensen, former vice president of Ohio Equipment Co., died February 26 in Cleveland, Ohio. Mr. Carstensen, who retired from Ohio Equipment in 1951, had formed Carstensen and Associates, a manufacturers' representative firm.

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We'll be delighted to greet you at our booth and happy to have you tour our plant near Philadelphia.
AT THE
5th NATIONAL MATERIALS HANDLING EXPOSITION
PHILADELPHIA, PA. • MAY 18-22, 1953
C&D BATTERIES, INC.
of Conshohocken, Pa.

Publication Service...

APRIL, 1953

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(1) Car Pullers

A new book on electric car spotters and drum-type car pullers has just been released. It describes a complete line of equipment for moving railroad cars and other heavy loads, including both vertical capstan and horizontal drum designs. Eighteen single drum car pullers are listed. Designed originally for moving railroad cars, Link-Belt car spotters and car pullers have been adapted to scores of industrial tasks involving horizontal haulage. Engineering information in the book includes instructions for calculating rope pulls required for moving railroad cars, considering such factors as track curvature, grades, condition of track and roadbed and atmospheric temperature. Typical layouts show positioning of the machines in a variety of applications. (2092). Link-Belt Co.

(2) Safety Trolley System

A new bulletin is available describing technical and installation data on a new safety trolley system. The system is applicable wherever current collectors are used such as for traveling cranes, ore bridges, ingot buggies, mine and power applications, portable electric tools and many other applications. Its construction features an inexpensive and highly efficient collector which can carry loads from 50 to 2000 amp. A conductor enclosed within an insulating sleeve, split at the bottom to provide for entrance. It surrounds a trolley shoe supported on a ball joint for flexible action. The shoe is made of copper alloy that matches the conductor, the latter serving as a guide track as well as the means to conduct current. The shoe is spring supported to compensate for vertical irregularities. Universal-Standard, Inc.

(3) Wire Rope Accessories

Just released is a catalog which is devoted to the Farrell-Cheek line of wire rope fittings and accessories. The booklet tells how these products are engineered to provide the right relationship between fittings and rope. They grip the rope or cable firmly and easily, without setting up any single points of high stress. This makes wire rope last longer. All fittings and accessories allow development of the full strength of the rope. (22). Farrell-Cheek Steel Co.

(4) Resistance Welding

The new "Ampco-weld" resistance welding catalog has just been released. Included in this 24-page catalog are the newly designed tips and holders which have recently been added to this line. Full information is given about the complete line of holders, tips, seam welder wheels, seam welder shafts and bushings and flash, butt, barrel and projection welding dies. Reference tables and comparative charts giving physical properties, applications and specification data are also included. (RW-1a). Ampco Metal, Inc.

(5) Sheathed Cables

For users of 0 to 5000 volt nonmetallic sheathed power cables, a new booklet, entitled "Okolite-Okaprene Cables for Direct Burial Installations," should be of special interest. Brief and factual, construction features, dimensional data, and installation recommendations are included in addition to current carrying capacity data not generally available. (OK-1066). Okonite Co.

(6) Temperature Controllers

Complete data about moderate-priced electronic instruments for two-position or proportional control is now available in a new 20-page catalog, " 'Electromax' Temperature and Conductivity Controllers," which has just been published. This fully-illustrated publication shows how three types of "Electromax" temperature controllers are being used to regulate temperatures up to 1000 F. It also describes a conductivity controller that is being used to check condensate purity. One section of this new catalog combines simple diagrams and descriptions to show how these temperature controllers apply two-position control or proportional control. Another section presents the packaged systems used for all three types of temperature control, and for two-position control of conductivity. Illustrations and specifications of the "control packages" appear side-by-side for easy reference. (ND47). Leeds & Northrup Co.

(7) Corrosion-Proof Plastic

Complete engineering facts, including information on fabrication and design factors, physical strength and chemical resistance of unplasticized, rigid polyvinyl chloride "Ampcoflex" are provided in a new bulletin. Resistance characteristics of "Ampcoflex" are charted to clearly indicate its applicability to specific industry corrosion problems, as well as its resistance to specific reagents at both low and high temperatures. A detailed tabulation of physical properties emphasizes the structural fitness of this lightweight, self-supporting material for various forms of corrosion-proof construction. Techniques of unplasticized, polyvinyl chloride fabrication are also discussed in the bulletin with illustrations of fume exhaust systems, tanks, ducts, and similar products fabricated with this plastic. (9-1). Atlas Mineral Products Co.

(8) Oil Circulating System

Literature is available describing a new oil circulating system known as "Meterflo." This development utilizes the Trabon positive piston displacement principle and, simply stated, is a sure method of controlling the flow of oil to every bearing under pressure. Features of this system include the following: Flow rates up to 80 cu in. per min. Rotary type pump units available in complete range of discharge capacities. Pump units with or without sumps include motor, pump, high-low dual acting pressure switch, cartridge type filter, pressure gages, oil level gage, and fill screen. Sturdy sump units include removable baffles for easy cleaning of tank. Metering valves accurately control flow of oil to

each bearing in the system. Pair of constantly blinking lights, actuated by flow of oil, available as optional signal equipment. The pressure switch, connected to the warning lights, permits ready identification of too-high or too-low pressure; blocked line; low oil supply; or will shut shown the machine being lubricated. (531). Trabon Engineering Corp.

(9) Pure Industrial Lubricants

For the harried plant maintenance superintendent or lubrication engineer who finds himself with too few oilers and too many lubricants, a new booklet just announced contains some timely suggestions. Entitled, "How to Simplify and Save with Pure Industrial Lubricants," this booklet sets up six simple steps to streamline your lubrication program, and goes on to point out that for the average plant a maximum of six lubricants will do a satisfactory job. Pure Oil Co.

(10) Scrap Bundler

The McLanahan scrap bundler, a machine designed for bundling stringy scrap metals and wire, is described in a new bulletin just published. The machine is available in two sizes: Model 18, which forms a bundle of scrap 18 in. in diam and 18 in. in length; and Model 24, which forms a bundle 24 in. in diam by 24 in. in length. Included in the bulletin are technical details, operating data and dimensional drawings. McLanahan and Stone Corp.

(11) Motor-Generator Reference

A motor and generator reference booklet to assist in the selection of motive power to handle most industrial applications is being made available. The 50-page pamphlet is reprinted from the 1952 edition of Lincoln's Industrial-Commercial Electrical Reference published by the Electrical Modernization Bureau, Inc. Text and illustrations on integral horsepower motors and generators for the book were furnished by Allis-Chalmers in cooperation with the Electrical Modernization Bureau. (51R7933). Allis-Chalmers Manufacturing Co.

(12) Industrial Power Distribution

Explaining the modern practices of electric power distribution is a manual entitled "Industrial Power Distribution Idea Book." This publication, designated GEA-5900, goes into a deeper analysis of each idea on industrial power distribution. Another available bulletin is GEA-5896, a booklet of case histories which show power distribution systems installed in industrial plants of various types throughout the nation. (GEA-5900 and GEA-5896). General Electric Co.

(13) Self-Aligning Bearings

A catalog is available that describes self-aligning spherical roller bearings. The new catalog has a new spherical roller bearing width tolerance chart; more complete thread, locknut and lockwasher data; a revised interchangeability chart, additional special bearing pictures; and has been reorganized for easier reference particularly where adapter type assemblies are concerned. The bulletin shows a complete line of spherical roller bearings and includes such engineering data as life expectancy, capacity ratings, life factors, installation and service factors, speed data, loads, fits, lubrication, and other pertinent information. All bearing types are illustrated in cross section. (200-C). Bantam Bearings division, Torrington Co.

(14) Millivoltmeter Instruments

A new catalog describes millivoltmeter type instruments: indicators, indicating electronic controllers and excess temperature safety cut-off controllers. Information on operation and applications of on-off, two-position, three-position and "pulse type" time-proportioning controllers is included as well as data on primary measuring elements, dimensions, ordering information and scale selection tables. (1053). Industrial Division, Minneapolis-Honeywell Regulator Co.

(15) Asbestos Electrical Insulation

"Quinterra-Quinorgo," is the title of a new 32-page publication just issued. It gives complete information about these electrical insulations made of purified asbestos . . . why they were developed, what their characteristics are, where they may be used to advantage. This publication is both a manual of facts and a descriptive brochure. For the designer of electrical equipment there are tables giving test data on physical and electrical properties. Test methods are fully explained and there is a separate table for each of the several types of "Quinterra" and "Quinorgo." For the production man there is advice on application techniques and equipment including step-by-step photographic coverage of methods now in use. These picture stories also illustrate improvements in finished products . . . space savings, lower weight, economy of materials and longer service life. The subjects for the picture stories range from heavy duty lifting magnets to hair curlers. In addition to photographs, many of the picture stories have sectional diagrams showing how, in a single piece of equipment, Quinterra and Quinorgo are used in many different places . . . for core tubes, layer insulation, wire wrapping, interlaminate insulation, end washers and the final wrapper insulation. The book concludes with a description of allied products such as "Quinterrabord," "Quinorgobord," "Quinterraglass" and composites or laminates that utilize "Quinterra" and "Quinorgo" but are manufactured by others. (EL-40A) Johns-Manville.

(16) Crane Manual

An excellently prepared book is available to you entitled: "How to Operate a Crane!" This booklet is helpful to the beginner as well as the seasoned operator. It includes safety rules and inspection-guide for daily report. Only one free copy will be sent. Quantity lots for plant distribution available at cost (40 cents postage prepaid). Electric Controller and Manufacturing Co.

(17) Split-Case Pumps

For supplying, circulating and boosting of water and clear liquids at medium and high heads, with special emphasis on product quality and long life rather than low initial price there has recently been completed the modernization and consolidation of a complete line of 2, 3, 4 and 5-stage, split-case pumps. The complete line of Type TU pumps is described in a new bulletin which is fully illustrated with pump cross sections, parts lists, dimensional data, design details and application photographs. (B-1400). Peerless Pump Division, Food Machinery and Chemical Corp.

(18) Belt Conveyor Repair

Complete information about how to use "Magic-Vulc" plastic rubber for repairing conveyor belts is contained in a new folder now being distributed. Names of industrial users and actual case history reports are included, showing that use of this compound has often doubled or tripled belt life, with savings in belt replacement costs mounting up to thousands of dollars. Use of the material to repair worn spots on conveyor belts quickly, easily and inexpensively is fully explained in the new folder. It can be readily applied by inexperienced workmen, according to the folder, without removing belt from pulley. No heat or special machinery is required, and the renovated belt is ready for use after only 12 hours of standing.

Among other applications, "Magic-Vulc" can also be used as a tough coating to protect all types of industrial equipment from corrosion and abrasion. Magic Chemical Co.

(19) Electronic Pyrometer

A bulletin describing the company's recently-announced free-vane electronic pyrometer controllers has just been published. The new bulletin illustrates the unit plug-in construction of the new controllers and describes their use for low-open, high-open, low-high, low-open-high, and low-normal-high- control. A model for proportional input control action is also described. Complete specifications and full-size reproductions of actual temperature scales are also included. (P1248). Bristol Co.

(20) Mercury-Vapor Lamps

A 25-page, revised and updated version of a mercury-vapor lamps booklet is available. The new booklet includes information on both the fluorescent-mercury and straight mercury type lamps. Besides giving general mercury lamp application information and performance data for all types and sizes, the booklet includes primary discussions about lamp and lumen maintenance, lamp temperature, and ambient temperature. A compact table gives standard information on all sizes and types of mercury lamps available. In addition, the booklet briefly tells the mercury-vapor story through sections on history, lamp construction, and mercury radiation characteristics. Also, a section on auxiliary equipment discusses typical mercury lamp circuitry, and performance of the lamp when used with various transformers. Special and ideal applications of all types and sizes of mercury-vapor lamps are pointed out in a special application section. (A-5112). Westinghouse Electric Corp., Lamp Division.

(21) Steel Mill Equipment

An interesting publication in the field of heavy machinery has just been issued. It deals with the design and construction of complete metal extrusion plants, rolling mill equipment, related process units, and hydraulic presses generally. The last category covers a capacity range of 600 to 20,000 tons. Described and illustrated is a variety of work along these lines in both ferrous and non-ferrous fields—engineered, built and erected by Lombard. The company undertakes complete plant or mill projects involving hot or cold metals, modernization programs, process lines, or unit equipment problems, on a "delivered, ready-to-operate" basis, or will prepare engineering reports therefore. (SE-52). Lombard Corp.

(22) Gears and Pinions

A new 14-page catalog describing alloy products for the steel industry has been published. Included in the catalog are pages on gears, bevel gears, mill pinions, spindles, coupling boxes, flanged crab couplers, sprockets, wheels for cranes and industrial cars, sheaves, and racks and pinions. Also part of this group is a page devoted to a comparison between the characteristics of 20 degree involute teeth gearing and standard 15 degree involute teeth gearing. All of these products are made by the Stroh process of casting, a method which combines a wearing surface of tough alloy steel with a base metal of low cost carbon steel. According to the manufacturer, this provides equipment with the wearing properties of alloy steel at a cost only slightly more than that of products made of plain carbon steel. Stroh Process Steel Co.

(23) Fractional Hp Gear-Motor

A new eight-page bulletin on fractional-horsepower gear-motors listing 61 standard models from which to choose has been announced as available. The publication describes the applications for fractional hp gear-motors and outlines a simple method of determining correct horsepower requirements with the use of an ordinary pipe wrench and fish scale. The bulletin contains descriptions, cut-away drawings, selection charts, and dimension tables for both concentric-shaft and right-angle shaft gear-motors, includes a section on maintenance pointers, and a complete list of G-E apparatus service shops throughout the country. (GEA-5678). General Electric Co.

(24) Dehydrators

The continuous removal of water vapor from air and other gases, to dew points as low as —100 F, is described in a new bulletin pertaining to dehydration equipment. "Selas Dehydrators," a 12-page bulletin, describes the needs for dehydration and the extent to which gas or air can be dried, practically, together with the operation of specified equipment. Three series of dehydrators are fully specified as to capacities and physical dimensions. A nomograph is provided for preliminary determinations of appropriate equipment. A separate data sheet with spaces for more specific operating information is included for mailing to the manufacturer so that more precise equipment recommendations can be made. (SC-1013). Selas Corp. of America.

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PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ADALET MANUFACTURING CO.	BULLETIN E-5-52	"Adalloy" vaportite fittings.
51	ADAMS CO., INC., R. P.	BULLETIN 691	Adams Poro-Stone filters.
52	AIR REDUCTION SALES CO.		"The Use of Oxyacetylene in Rolling Mills."
53	AJAX FLEXIBLE COUPLING CO., INC.	BULLETIN 50	Ajax dihedral couplings.
54	ALDRICH PUMP CO.	DATA SHEET 61-2	Aldrich descaling nozzles.
55	ALLIS-CHALMERS MANUFACTURING CO.	BULLETIN 14B6505A	A-C mill type 260 d-c contactors.
56	AMERICAN AIR FILTER CO., INC.	BULLETIN 241A	Multi-duty air filters.
57	AMERICAN CHEMICAL PAINT CO.		Descriptive folder on "Rodine."
58	BEDFORD FOUNDRY AND MACHINE CO.		Bedford cranes.
59	BLISS CO., E. W.		52-page rolling mill brochure available.
60	BLOOM ENGINEERING CO., INC.	BULLETIN 2183	Bloom Ka-WELD.
61	BROOKS OIL CO.		The Brooks oil story.
62	BROWNING AND CO., INC., VICTOR R.	BULLETIN "E"	Browning mill type cranes.
63	CLEVELAND WORM AND GEAR CO.	BULLETIN 135	Cleveland type CU worm gear drives.
64	COLUMBIA ELECTRIC MANUFACTURING CO.		Columbia motor generators.
65	CRANE CO.	FOLDER AD 1667	Crane clamp gate valves.
66	CUNNINGHAM CO., M. E.		"Luminum Line" pipe and plate marker.
67	DE LAVAL SEPARATOR CO.	BULLETIN 500	De Laval mill lubrication systems.
68	DIAMOND POWER SPECIALTY CORP.	BULLETIN 1025 T	Diamond "Utiliscope."
69	DOWELL, INC.		Chemical cleaning for steel mill equipment.
70	DRAVO CORP.	BULLETIN PS-1301-132	Dravo crane cab conditioners.
71	ELECTRIC SERVICE MANUFACTURING CO.		Keystone electrical products.
72	ELLIOTT CO., CROCKER-WHEELER DIVISION		Mill motor bulletin available.
73	ENTERPRISE CO.	BULLETIN 501	Enterprise roller conveyor units.
74	FLOWER MANUFACTURING CO., D. B.	CATALOG 41	Flower brush holders.
75	FOOTE BROS. GEAR AND MACHINE CORP.	BULLETIN MPB	Maxi-Power drives.
76	FOXBORO CO.	BULLETIN 460	Foxboro flow meters.
77	FURNACE ENGINEERS, INC.		F.E.I. heating lines.
78	GENERAL ELECTRIC CO.	BULLETIN GEA-5570	G-E auxiliary-drive systems.
79	GENERAL ELECTRIC CO.	BULLETIN GEA-5332 BULLETIN GEA-5426	Low-speed synchronous motors. High-speed synchronous motors.
80	HARNISCHFEGER CORP.	BULLETIN C-42	P&H mill type cranes.
81	INDUSTRIAL GEAR MFG. CO.		"A Pictorial Trip Through Industrial Gear."
82	JOHNS-MANVILLE	BROCHURE IN-115A	J-M insulating materials for service through 3000 F.
83	KAISER ALUMINUM & CHEMICAL SALES, INC.		Bulletin gives advantages of Permanente 165 and Permanente 84.
84	LEEDS AND NORTHRUP CO.	CATALOG ND46(1)	L&N speedomax.
85	LINTERN CORP.	BULLETIN AC-533	Crane cab conditioning.
86	LOVEJOY FLEXIBLE COUPLING CO.		Lovejoy flexible couplings.
87	MEDART CO.		Medart rotary straighteners.
88	MINNEAPOLIS-HONEYWELL REGULATOR CO., INDUSTRIAL DIVISION	DATA SHEET NO. 4.3-4a	Metered fuel-air ratio control.
89	MORGAN ENGINEERING CO.	BULLETIN NO. 16-A	Describes Morgan installations.
90	NATIONAL ALLOY DIVISION, BLAW-KNOX CO.	BULLETIN 2041	Picture story of NA products and procedures.
91	OKONITE CO.	BULLETIN IS-1053	Stability and performance of Okolite-Okoprene.
92	PITTSBURGH LECTROMELT FURNACE CORP.	CATALOG 8	Lectromelt furnaces.
93	POOLE FOUNDRY AND MACHINE CO.		Catalog on flexible couplings.
94	POST-GLOVER ELECTRIC CO.	BULLETIN 500	P-G steel grid resistors.
95	PYLE-NATIONAL CO.	BULLETIN 1150	Complete listings of electrical equipment.
96	RAMTITE CO.		Catalog on steel plant furnace construction.
97	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN B-2201	Motor bearings.
98	STOODY CO.		Stoody Castings.
99	TAYLOR SONS CO., CHAS.	BULLETIN 507	Tayco-40 silica cement.
100	TAYLOR CHAIN CO., S. G.		TM alloy steel downtown magnet chain.
101	TIMKEN ROLLER BEARING CO.		165 pages describing bearing applications in all types of rolling mill equipment.
102	UNITED STATES GRAPHITE CO.		Catalog on USG brushes.
103	WAGNER ELECTRIC CORP.	BULLETINS TU-180 AND TU-181	Wagner transformers.
104	WALDRON CORP., JOHN		Waldron couplings.
105	WESTINGHOUSE ELECTRIC CORP.	BOOKLET B-5417	Load-O-Matic a-c crane hoist control.
106	ZURN MFG. CO., J. A.	MANUAL DATA NO. 952	Zurn low pressure drop strainers.

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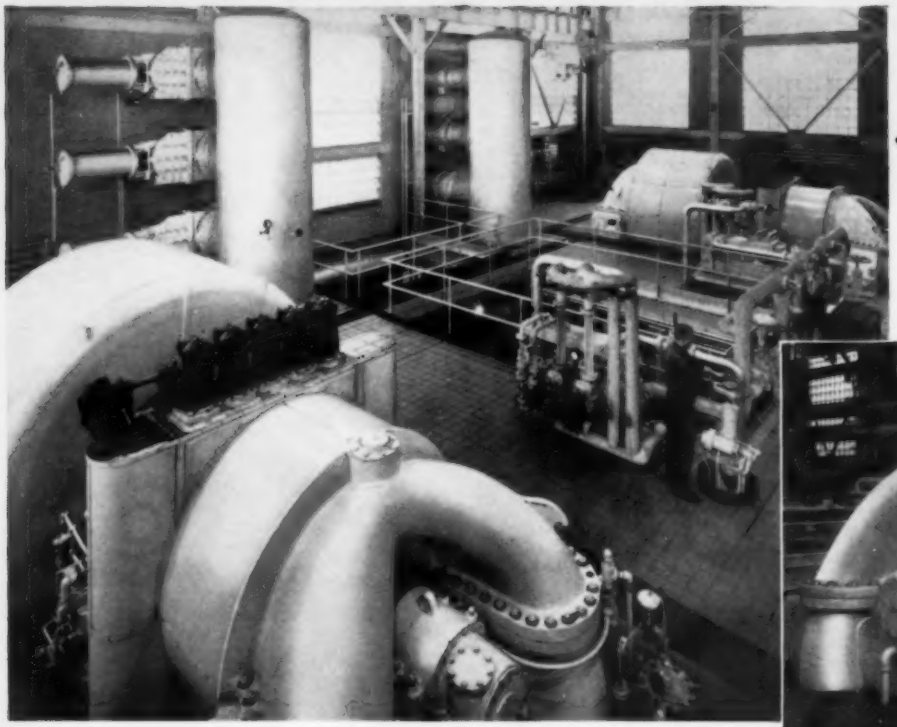

General view of blast furnace blowing room, showing the two 100,000 cfm I-R Turbo-Blowers and 11,500 hp I-R Steam Turbines.

Blower end of one of the 100,000 cfm blast furnace Turbo-Blowers.

COMPLETE I-R BLOWER PLANT

helps another large steel mill maintain continuous high production

Like other leading steel producers throughout the country, this large Western Pennsylvania steel mill has placed full confidence in Ingersoll-Rand equipment for the vital blower plant.

Here confidence means more than peace of mind. It means continuous, uninterrupted production of our most essential metal. For any failure of the turbo-blower equipment would mean a costly shut-down of the blast furnace—and a serious loss of plant output.

That's one important reason why Ingersoll-Rand has long been a major supplier to the steel industry—where *proved dependability* of equipment is absolutely essential. An Ingersoll-Rand engineer will be glad to discuss your blower, compressor, condenser or pump problems with you. Call on him whenever he can help you.

Ingersoll-Rand Equipment installed at this Western Pennsylvania Steel Mill

- *Two I-R Blast Furnace Turbo-Blowers,* each driven by an 11,500 hp I-R Steam Turbine and compressing 100,000 cfm of air to 30 lb.
- *Two I-R Surface Condensers* serving the blower turbines. Two-pass, vertically divided, each with 10,000 sq. ft. of surface.
- *Two I-R Vertical Condensate Pumps* for the surface condensers, returning water to boiler recycle.
- *Two I-R Steam-Jet Air Ejectors* serving the surface condensers.
- *Two I-R Turbo-Blowers* for compressing 15,000 cfm of coke oven gas to 10 lb. Each driven by a 700 hp motor.
- *Three I-R Four-Corner PRE Compressors* for boosting coke oven gas to 25 lb. Each driven by a 1250 hp motor.
- *Two I-R Single Stage ES Dry Vacuum Pumps,* 100 hp each, for the desulfurizing unit.

Also many small I-R Centrifugal Pumps in the coke plant.

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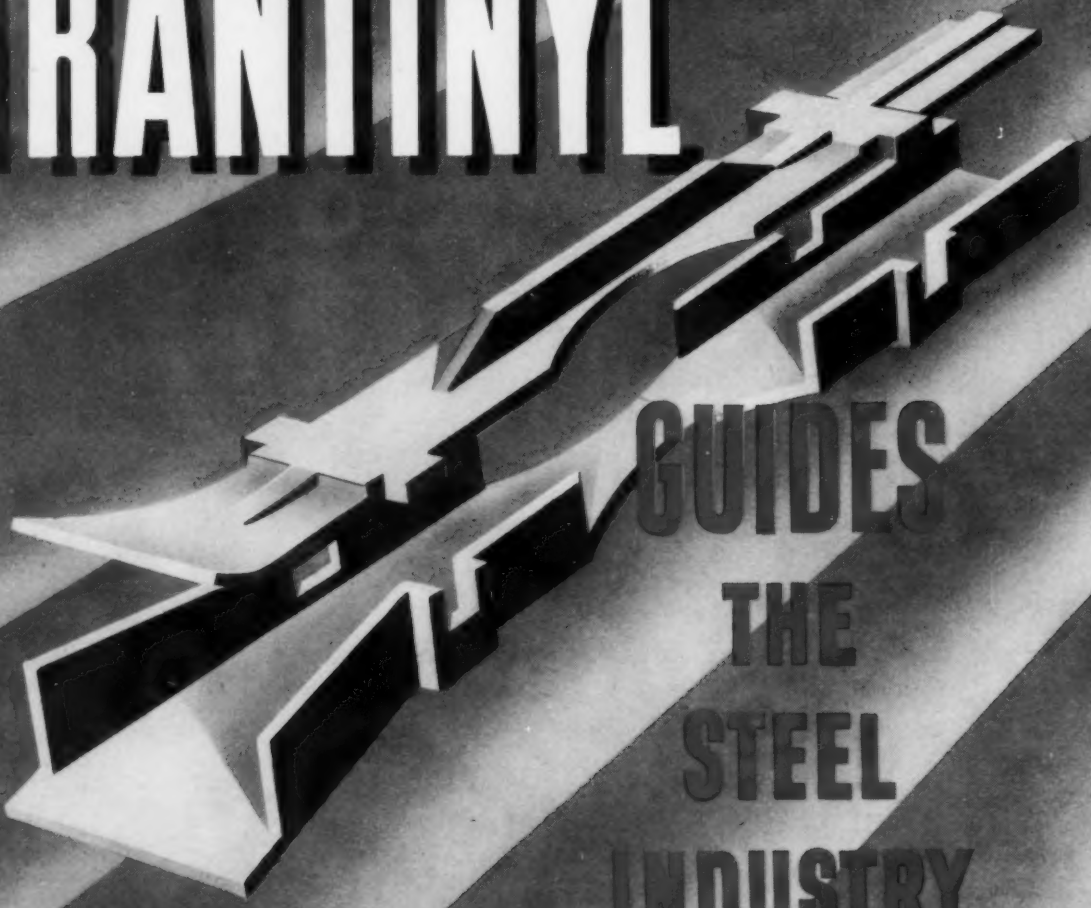

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Hagan Ring Balance Flow Meters give dependable readings over the chart range, and give good response at low flow rates.

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The simplicity of design, coupled with sturdy construction, assure long meter life and low maintenance costs.

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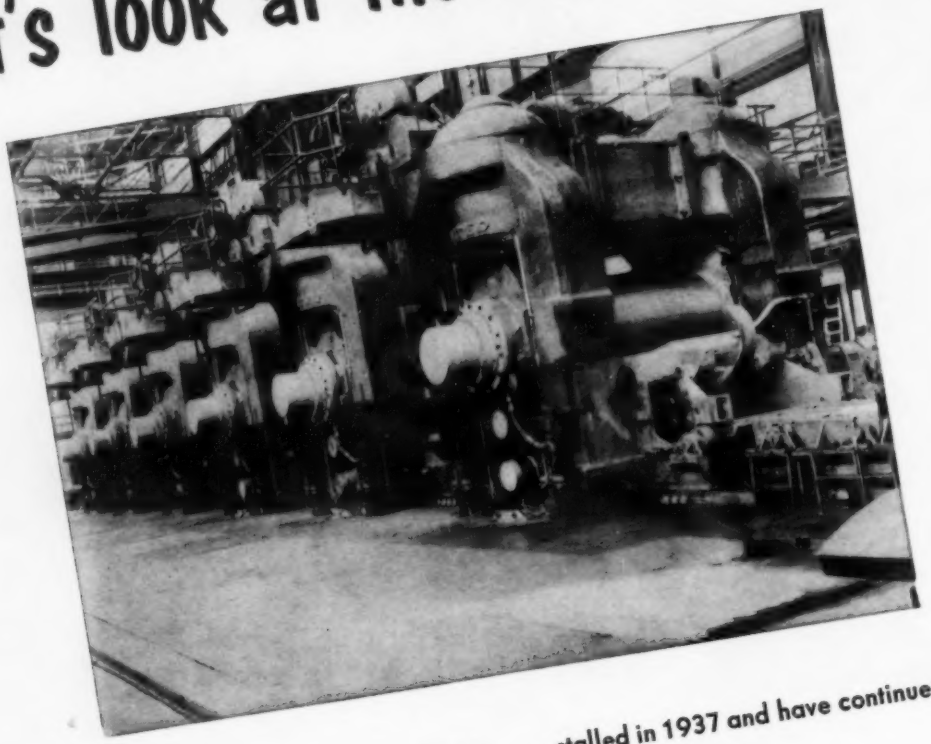
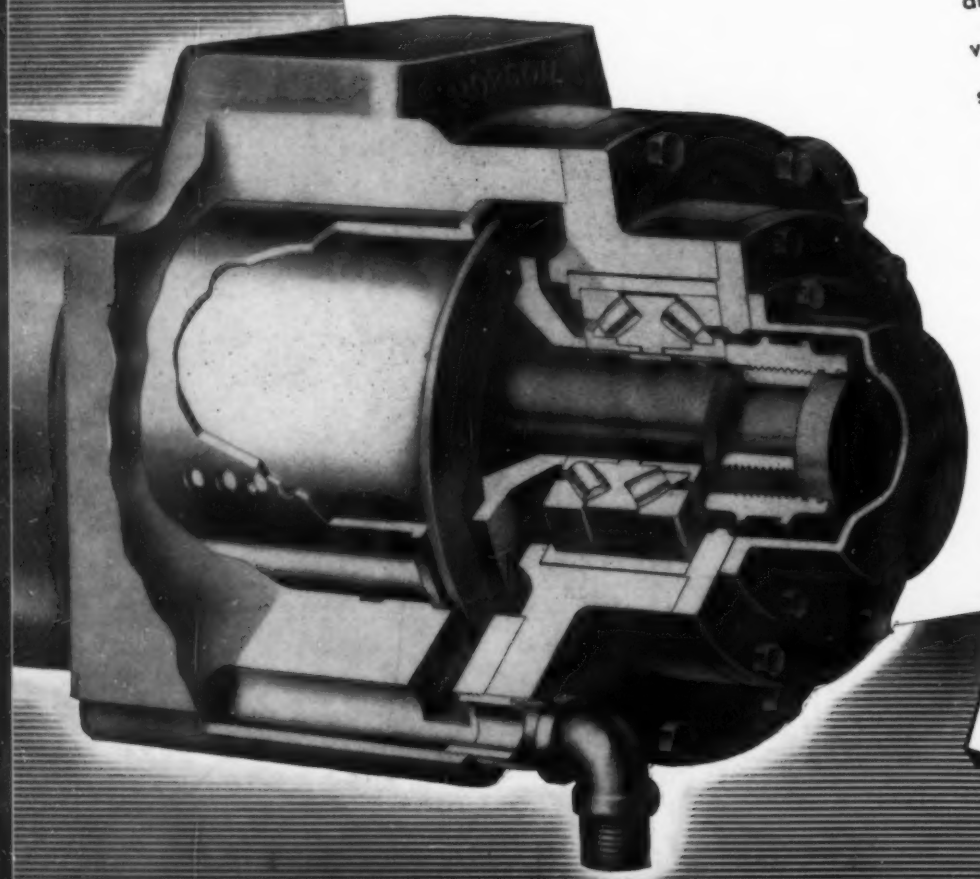


THIS picture shows Morgoil Bearings in operation in the four high hot strip mill at Corrigan-McKinney Works, Republic Steel Corp., Cleveland, Ohio. They were installed in 1937 and have continued to give outstanding service.

The reasons why Morgoils perform so efficiently stem from the simplicity of their design, their accuracy of manufacture and the basic conception that a bearing operating on a film of oil offers tremendous advantages from a load-carrying and wear standpoint.

Let us give you the full Morgoil story.



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International Construction Co.
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MORGAN WORCESTER

Rolling Mills - Wire Mills - Gas Producer Machines - Regenerative Furnace Control

Equipment News...

ROTARY STRAIGHTENER

▲ Several important design improvements in the tubing and pipe rotary straightener AX, first placed on the market in 1944, are announced by Mackintosh-Hemphill Co.

The straightener, its two 3 hp motors, and the drive spindles are now mounted on a unit steel table. While bolt holes in table feet facilitate permanent installation on production lines, the complete unit can be quickly relocated as production requirements affect shop layouts.

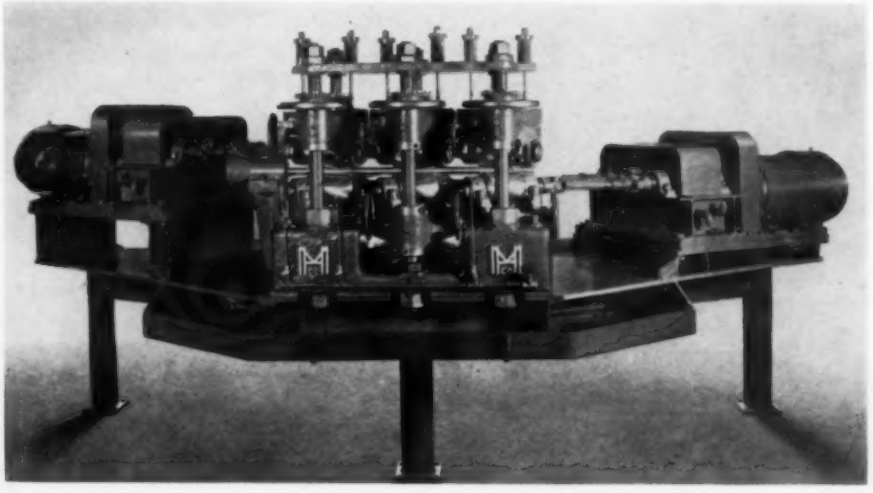
A circulating flood lubrication system for the straightener's six driven rolls is now an integral part of the machine design. Experience gained with the Model AX in a variety of plants, particularly those producing aluminum and other non-ferrous tubing, indicated that a petroleum-base liquid lubricant was advisable. This lubricant, directed at the points where tube or pipe is in contact with each pair of rolls, materially improved straightening, dissolved the residue of the solutions used in drawing operations, washed away metal particles which might mar tube surface, and lengthened roll life.

To assure good plant housekeeping, operator safety and economy in lubricant use, a steel shield now deflects any splashing lubricant into the collection tray. This shield has two shatterproof glass inspection windows; two handles ease the removal of the shield as desired.

Another safety feature of the improved model are covers for the six drive spindles. Completely shielding the fast-spinning drives, the covers are hinged to allow ample space for spindle servicing. Where volatile lubricants are used, explosion-proof motors are standard equipment for driving the straightener rolls and for the circulating lubrication system.

The guideless rotary straightener continues to have the capacity to straighten tubing or pipe from ¼ to 1½ in. in diam. It has a production speed variable up to 350 fpm. Floor space required is 7 ft 10 in. by 5 ft 5 in.

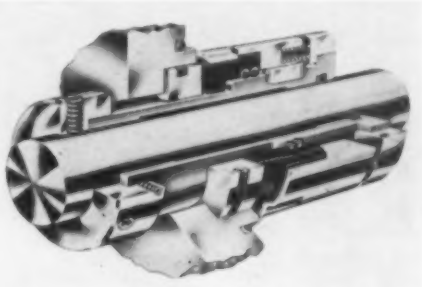
Mounted on a steel table unit, this improved straightener boasts a circulating flood lubrication system as an integral part of the machine design. Added safety features include spindle covers and a steel shield to protect against splashing lubricants. Explosion-proof motors are standard equipment where volatile lubricants are used.



MECHANICAL SEAL

▲ A heavy-duty mechanical seal which will withstand pressures up to 1000 psi is now being offered by the Crane Packing Co. Known as the "Type 8-B Shaft Seal," it is designed for applications where ruggedness to withstand high pressures is an important factor. A packaged unit, the shaft seal is factory inspected and furnished preassembled on a sleeve for ready installation. When used with split case pumps it is not necessary to lift the upper half of the casing to install or remove the seal. Extremely compact design adapts it for use in conventional pump stuffing boxes.

Incorporating a rotating sealing washer and a "floating" stationary seat, balance is accomplished by lowering the washer face to a point where stuffing box pressure is not



exerted against the sealing area. To insure peak efficiency, mating faces of the washer and seat are precision-lapped to 0.0000232 in.

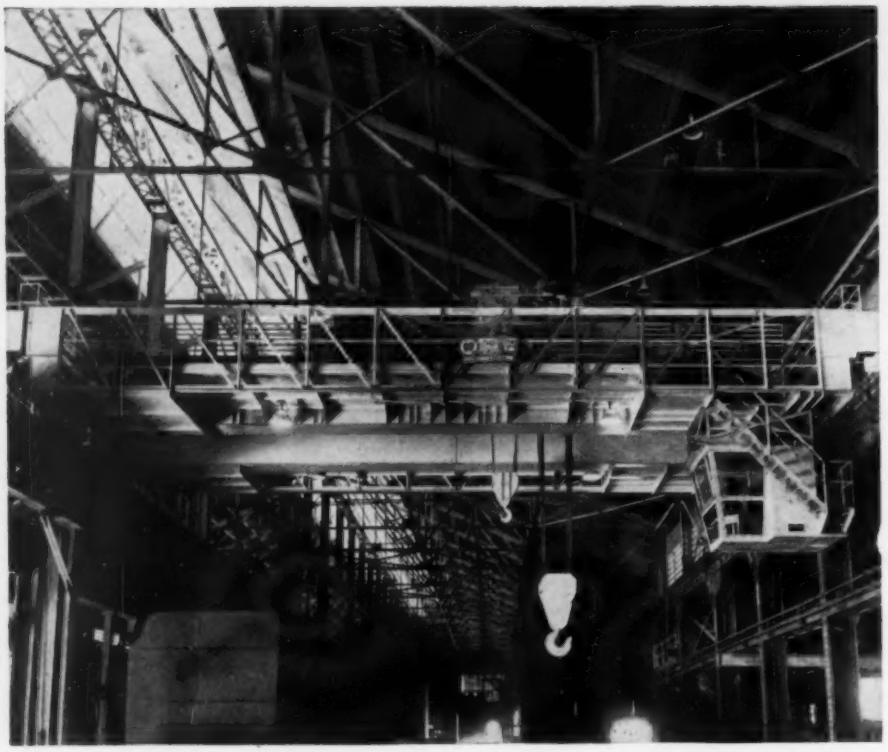
The rotating assembly consists of a retainer positively driven by the sleeve, with the washer driven from dents in the retainer. The assembly is held in contact with the lapped face of the seat by means of multiple springs equally spaced around the sleeve at the back of the retainer.

"O" Rings provide sealing between sleeve and shaft and also between washer and sleeve. This affords sufficient flexibility in the rotating assembly to compensate for axial and radial shaft movement and for normal wear of sealing faces. Another "O" Ring is used between the stationary seat and end plate as a cushioning to prevent stresses on the highly lapped seat face.

ADAPTABLE CONTROLLER

▲ A new controller especially adapted for cascade control systems and for program control has been designed by the industrial division of Minneapolis-Honeywell Regulator Co. The instrument has a motor-driven index.

The new device, although not listed as a program controller, is extremely flexible for program control when equipped with proper externally connected accessories. It can be used for a cascade control system when the



Sixty-ton Bedford Crane with air-conditioned cab in the new melt shop of The Timken Roller Bearing Co., Canton, Ohio. Working directly over the severe flash heat of top charging electric furnaces, it positions and dumps approximately 40 tons of scrap per swing.

Backed by 50 Years of *Specialized Experience*

The dependability of Bedford Cranes has been repeatedly proven in the past fifty years by their daily performance in heavy-industry applications in all parts of the world.

"Custom-Built" to precise specifications for each installation, Bedford Cranes are engineered to function dependably as an integral part of the user's production equipment.

A half-century of experience in designing and building cranes to exacting industry requirements . . . and the utilization of the latest production equipment, contributes to the superiority of every Bedford Crane. Owners testify to their smooth, low-cost operation; quick, positive response and rugged reliability.

Bedford Overhead Electric Traveling Cranes are available in a wide range of types and sizes from 5 tons to 350 tons . . . including the *right* unit specifically engineered for *your* application.

(Write for complete catalog describing Bedford Cranes in detail.)

BEDFORD CRANES SERVICE

BEDFORD CRANES

BEDFORD FOUNDRY & MACHINE COMPANY, INC. · BEDFORD, INDIANA

primary instrument is equipped with electrical contacts, making it invaluable for remotely positioning a set point where air for pneumatic control is not always available.

The new controller consists of a standard thermometer controller plus an index-setting mechanism that includes a reversible motor, a gear train, and two cam-actuated Micro precision switches. When its three color-coded indexes function to provide control action the green motor-driven index travels at a rate dependent upon the speed of the reversible motor; the red and purple indexes are limiting indexes, set manually to stop the motion of the driven index at predetermined points. Two external two-position knobs, located on the front of the instrument case, provide means for setting the indexes. An additional button permits rapid resetting of the driven index to its starting position at any time during a program.

This type of controller is particularly useful where programs must be varied from batch to batch, such as in the textile industry. In the textile industry there is a complexity of modern dyeing and finishing techniques and schedules are subject to frequent changes. With the motor-driven index, a program can be established in a few seconds simply by adjusting the index setting knobs, providing a decided advantage over the cam controller requiring new cams for each program.

GIANT STEEL INGOT

▲ The heavy press program of the United States Air Force advanced another step at Homestead, Pa., district works recently when the U. S. Steel plant drew from its furnaces a white hot half-million pound ingot.

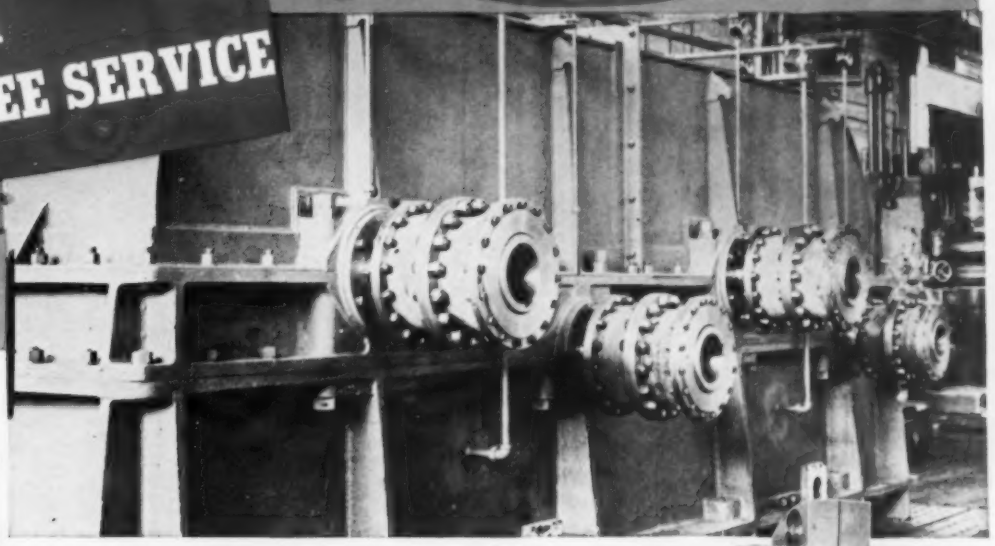
The giant piece of steel which was heated to a temperature of 2300 F will be press forged, heat treated and machined to proper size and strength to form a tie-rod for a 20,000-ton extrusion press built for the manufacture of intricate airplane parts.

The Homestead forgings division has been actively engaged in this program since the preliminary design stages early in 1951. U. S. Steel's activity in the program, in cooperation with the United States Air Force and with the press builders and operators, has been directed in two lines:

(1) Melting, forging, heat treating and machining the giant steel forgings

INDUSTRY'S CHOICE FOR TROUBLE-FREE SERVICE

Small sizes are now packaged for ease of handling and stocking

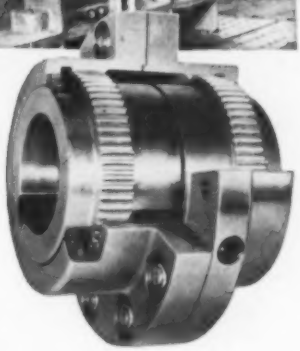


the rugged, dependable

WALDRON

ADVANCED DESIGN

GEAR COUPLINGS



NEW!

WALDRON Junior GEAR COUPLING

First light weight, inexpensive coupling of gear type construction for nominal bores—⅜", ½", ⅝", ¾". Made of unbreakable nylon. Weight 2½ ozs. Non-corrosive, non-magnetic. Requires no lubrication. Full particulars on request.

built to eliminate the usual sources of costly coupling failure

The most dependable couplings are those of gear type construction. And throughout industry the WALDRON Gear Coupling is recognized as the most advanced in design and construction of all gear couplings. Its popularity stems from its many design refinements and operating advantages which combine to insure longer service life. Features such as WALDRON all steel construction, one piece cover sleeve, crowned gear teeth, longer lining up surface, automatic lubrication, less rotating weight and others, afford extra protection against costly shutdowns for repairs or replacements. Performance records of WALDRON Gear Couplings over many years have made them first choice of the leading equipment builders. For your gear coupling—specify WALDRON.

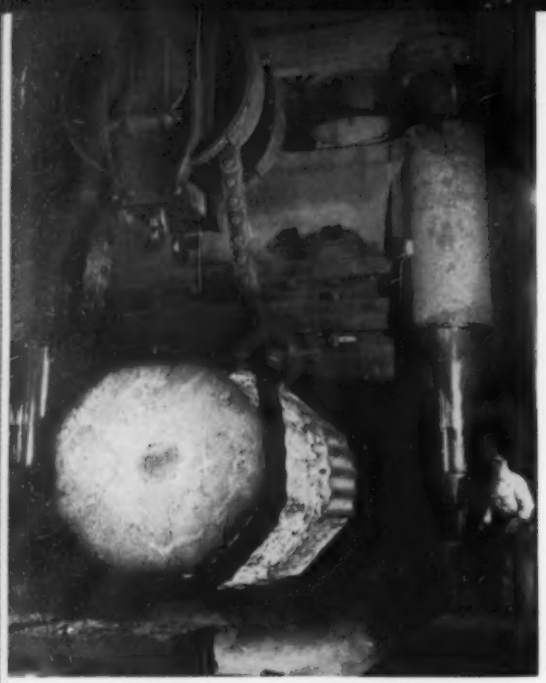
Waldron Couplings embody more than 40 years of coupling building experience. Available in all types and sizes. Design easily adapted for special applications. Write for descriptive catalog and specific engineering data.

JOHN WALDRON CORPORATION

Waldron Series "A" and Junior Gear Couplings Francke Pin Type Coupling Anchor-Waldron Overload Cut-Outs

NEW BRUNSWICK • NEW JERSEY

Sales Representatives In Principal Cities • In Canada—Peacock Brothers, Ltd.



This half-million lb ingot drawn from furnaces at U. S. Steel's Homestead plant will form a tie-rod for a 20,000-ton extrusion press for aircraft parts.

required for construction of the vertical die forging and horizontal extrusion presses.

(2) Development of manufacturing processes to handle the large tools required for operation of both types of presses. These include huge die blocks for the vertical forging presses and massive containers, container liners and rams for the extrusion presses — in sizes and weights beyond the facility limitations of the present die block and extrusion tool manufacturers.

Starting with a 500,000 lb ingot, the tie-rod will be rough forged at the Homestead works. Leaving there weighing 291,500 lb, it will be shipped to U. S. Steel operations in South Charleston, W. Va. for machining.

The finished product will weigh 195,000 lb and measure 63 ft 11½ in. long with a diameter at the collar of 43¾ in. and 41 in. at the shaft.

The forgings division at Homestead, with melting and mold capacity for 525,000 lb ingots, 7500 and 12,000-ton forging presses, and large turning and boring lathes, is one of the three forge shops in the country equipped to produce the mammoth steel forgings required for the Air Force program.

ALLOY-COATED ELECTRODE

▲ While there are a good many electrodes on the market which are variously recommended as suitable for general welding and build-up, many of these rods do not supply all the properties required for rebuilding of steel parts preparatory to a hard-facing overlay. It has frequently been found that failure of such overlays is directly traceable to movement or cold flowing of the underbase when subjected to heavy compression or impact. The underbase must have high tensile strength and rigidity to properly support the hard metal.

A new electrode recently marketed under the name "Stoody Build-Up" by Stoody Co. has been developed with the sole idea of providing the exact properties necessary in a material used for rebuilding carbon steel and alloy steel parts—sound deposits, high tensile strength, toughness and resistance to cold flowing. As an underbase it is generally recommended for such parts as drive sprockets, churn drills, shovel drive tumblers and house rolls, tractor rollers and idlers, tool joint shoulders and clutch jaws.

The electrode is an extruded alloy-coated electrode designed to produce an alloy steel deposit of consistent medium hardness of 29-31 Rockwell C under normal conditions. Deposits are affected by heat treatment and will react to abnormal temperature ranges like any other alloy steel.

While the build-up is not a hard-facing alloy and not intended for such applications, it has certain limited uses as a final overlay on equipment where impact is the principal wear factor — steel shafting, gears and tractor rails. Deposits are machinable with high speed tools.

WATER CONTROL VALVE

▲ Manufacturing plants, in their constant efforts to reduce operating costs, are turning to a hitherto unrecognized source of saving, that of water conservation within the plant.

Before the recent program, little or nothing was done to conserve or reduce the cost of water. Because the major use of water is in the cooling of various machines, such water cannot only be saved from constant flow when the machine is not in use, but it can also be recirculated in order to

Enterprise PIPE ROLLER CONVEYORS

ENTERPRISE Roller Conveyor Units are modern industry's answer to conveying problems in many mill runout table applications. Two of many outstanding features are individual drives and rugged all-steel construction. These units are versatile, economical and easily installed.

Write for Bulletin 501

ESTABLISHED 1870

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MACHINERY BUILDERS & ENGINEERS

SUBSIDIARY OF WM. K. STAMETS COMPANY—PITTSBURGH

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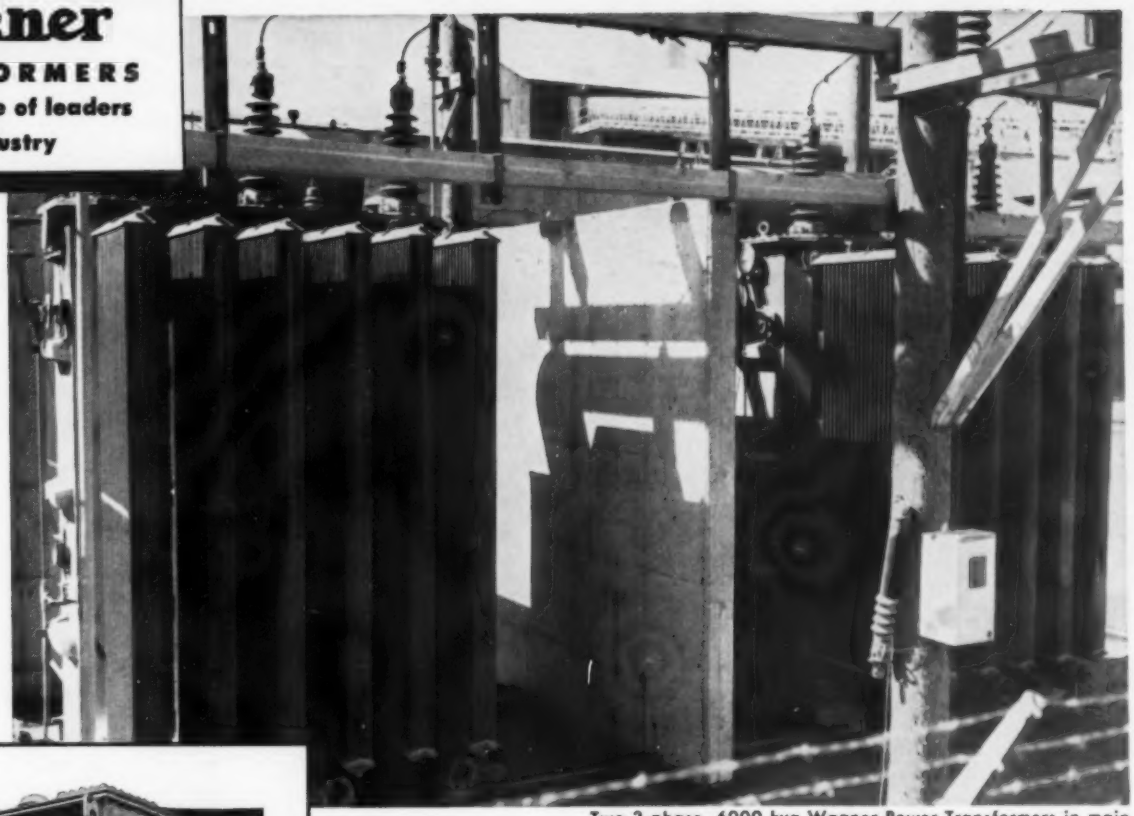
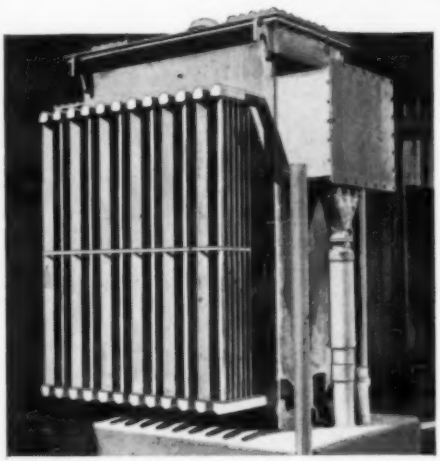
Wagner
TRANSFORMERS
... the choice of leaders in industry



Two 3-phase, 6000 kva Wagner Power Transformers in main substation — Missouri Portland Cement Company, St. Louis.



ONE OF FIVE Wagner 3-phase, non-inflammable liquid filled unit substation transformers used in this installation. Each transformer is rated 750 kva, 2400 to 480 volts, 60 cycle.

Wagner Power Transformers meet ASA C57 standards

Now, you can simplify your specifications and gain the advantages of improved design at reduced cost by ordering *standardized* Wagner Power Transformers. Wagner Transformers meet all ASA C57 standards for voltage ratings, taps, impedances and both standard and optional mechanical features. Get full information from your nearby Wagner engineer, or write us.

Wagner Transformers selected for modernized distribution system in midwest cement plant

The modernized Prospect Hill plant of the Missouri Portland Cement Company provides a fine example of an up to date distribution system in an application where considerable amounts of power are utilized at primary voltages. 12,000 kva of transformer capacity was required for connected and demand loads, with provisions for a 33 percent increase in capacity for future expansion.

Two Wagner 3-phase power transformers, each rated 6000 kva, with an ultimate of 8000 kva to be obtained with the addition of cooling fans, were used to meet this requirement for the main substation.

The distribution system uses five 750 kva unit substations, each located as close as possible to the load centers they serve. These substations are powered by 3-phase Wagner unit substation transformers, each with identical specifications.

Wagner transformers were chosen for this installation, as they are for a great many industrial and power company installations, because of their ability to give continuous service over unusually long periods of time. Consult a Wagner engineer on your next transformer installation, or write for Bulletins TU-180 and TU-181 for full information.

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

Wagner Electric Corporation EST. WE 1891

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS – AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

T53-6

The Moving Airstream Touches the Worker for only a few Seconds at a Time
Perfect Comfort
NO SICKENING HOT BLAST!
THAT is the big difference between most unit heaters and the WING Revolving Heater. The soft airstream from the slowly revolving discharge outlets creates a warm, gentle, yet live sensation of comfortable well-being that is without equal for keeping workers contented and productive.
. . And in the Summer time with the steam turned off and the fans on, these same revolving discharge outlets will create a pleasing, cooling effect on the hottest days.
Write for Bulletin HR-6
Wing
L.J. Wing Mfg. Co.
Linden, New Jersey
Factories: Linden, N. J. & Montreal, Can.
In Europe: Etab. WANSON, Brussels, Belgium
UNIT HEATERS
FANS
BLOWERS
DRAFT INDUCERS
TURBINES

perform the cooling operation more effectively.

Solenoid electric valves, manufactured by Atkomatic Valve Co. used in conjunction with starting switches and thermostatic controls now control the water flow so effectively that it is used only when the temperatures build above a pre-determined level or when the machine is turned on for operation. Meter tests show that through thermostatically controlled solenoid electric valves, 60 to 70 per cent of the water is saved. This

amount varies with the type of machine or the cooling operation performed. Air compressors, heavy presses and degreasers as well as spot welders are served by such an efficient system and in large plants the savings effected can run as high as $16,000 per year.

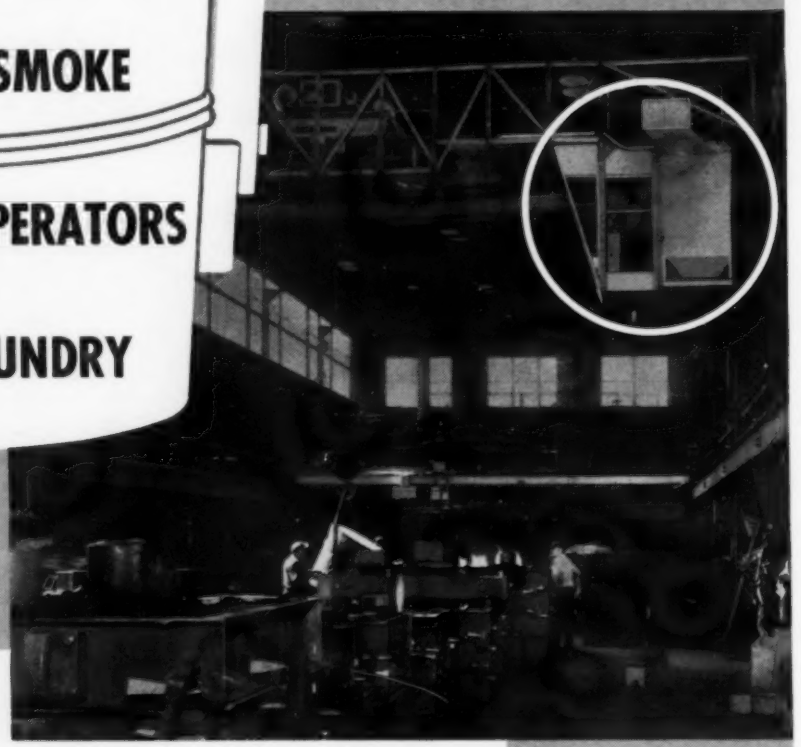
The savings made through the use of these solenoid electric valves is not only effected in dollars saved but in the conservation of our natural resources. Throughout the United States in the past few years numerous municipalities have been faced with water shortages which not only became grave, but which imperiled the safety of the community. Because of the enormous quantities of water used in industry, it is felt that more rigid control over our water supply through the use of electrically actuated valves is the answer to the immediate effecting of great saving in our water supply. Municipalities are turning more attention to this problem and are suggesting that steps be taken in all ways possible to prevent the unnecessary waste of water.

In one plant alone, where a cooling

FOR HOTTER FUELS
BIGGER LOADS—
UNION
DOUBLE-LIFE HEAD
CHARGING BOXES
These specially designed Union Boxes are cast from UNIVAN®—a special alloy steel that maintains its superior strength under extreme conditions of heat, cold and shock. They're made for greater loads and large production requirements. And we welcome the opportunity to prove that you can do a faster charging job for a longer time at less cost with Union Double-Life Head Boxes. For conditions where smaller loads are desirable, Union carbon steel charging boxes are both efficient and economical. Your request for further details and prices will receive immediate attention—we are now in a position to meet your delivery requirements.
Cinder Pots • Slag Pots • Peels • Gears • Universal Couplings • Spindles • Ingot Cars • Charging Cars • Miscellaneous steel castings
UNIVAN
BLAW-KNOX COMPANY
UNION STEEL
CASTINGS DIVISION
PITTSBURGH 22
PENNSYLVANIA
BLAW-KNOX

DRAVO CONDITIONERS ELIMINATE FUMES AND SMOKE

FOR CRANE OPERATORS AT GREENLEE BROTHERS FOUNDRY



Operations in the foundry at Greenlee Brothers & Company had been hampered by excessive smoke and fumes. Smoke, which resulted from burning of residual oil and flour, and fumes from core ovens made it impossible for crane operators to work at maximum efficiency. Installation of Dravo Crane Cab Conditioners eliminated these intolerable conditions, greatly improving the efficiency and alertness of crane operators while safe-guarding their health.

Dravo Crane Cab Conditioners are ruggedly-constructed ventilating units, fabricated specifically for rough industrial usage and are especially designed for conditions which require fume removal. These units provide a continuous supply of air from which dust and dirt has been removed. Electric strip heaters maintain temperatures of 68° to 72° F. in crane cabs during winter months.

These units can be easily installed vertically, horizontally, or at any angle which space permits. A separate control cabinet allows on-off operations and regulates heat. Dravo Crane Cab Conditioners are also ideal for installation on mobile cranes, pulpits and other equipment operating where similar conditions exist.

Only Dravo has a complete line of crane cab coolers and conditioners. All units are available now! Write or phone your nearest Dravo office today for more information and have our representative call on you. Ask for Bulletin No. PS-1301-132.

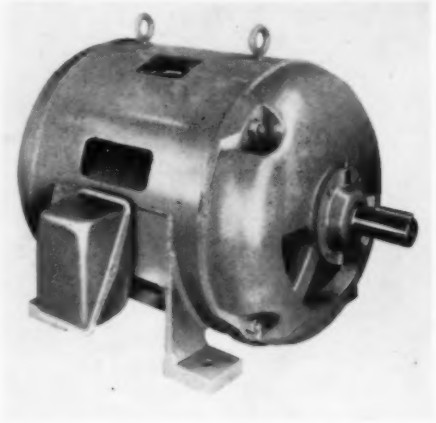
DRAVO

DRAVO
CORPORATION
Dravo Building, Fifth and Liberty Avenues
Pittsburgh 22, Pa.
ATLANTA . BOSTON . CHICAGO
CINCINNATI . CLEVELAND . DETROIT
INDIANAPOLIS . NEW YORK . PHILADELPHIA
ST. LOUIS . WASHINGTON

operation formerly sent 1,000,000 gal of water into the sewers, this program and emphasis now has reduced the loss to ¼th of the original figure.

T-TYPE MOTOR FRAME

▲ Modernization of the electric motor frames in the higher horsepower ratings of the T-type design was announced recently by Electro Dynamic Division, General Dynamics Corp. The lower ratings, from 1 to 60 hp, were modernized earlier. Now, the entire T-type line, which runs as high as 250 hp, will have the new modern frames. The higher ratings, from frame size 444 to 586 of drip-proof



construction, will offer the advantages of rolled steel frames and cast iron end bells, assuring permanent alignment. Bearing caps at the shaft ends, leading to longer bearing life, will be another advantage of the new design.

This modernization of the T-type design is a part of the overall redesigning of their electric motors and generators presently being carried out by this company.

CIRCUIT BREAKERS

▲ Forty-one circuit breakers with the high interrupting rating of 25,000,000 kva have been ordered from the General Electric Co.'s switchgear department in Philadelphia, Pa.

Each of these breakers will weigh 80 tons and require three freight cars for shipping it to its installation site. Each unit will stand more than 25 ft high and have three 4000 gal oil tanks measuring more than 11 ft in diam.

The breakers will be for use on 330,000 volt transmission lines, each capable of carrying more power than any lines now in existence — more than a million kilowatts.

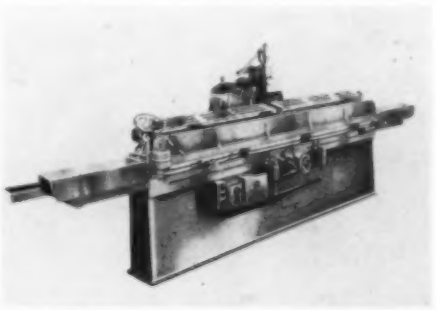
During short circuit interruptions on power lines, each of the breakers will be capable of safely dissipating enough energy to lift a 100-ton locomotive 460 ft in the air in 1/20th of a second. Lightning is the chief cause of short circuits on high voltage power lines, according to G-E engineers.

These breakers are scheduled to be shipped in 1954 and 1955. Among the first to be completed will be nine for the American Gas and Electric Co. of New York, N. Y., for installation on its properties in Ohio and Indiana.

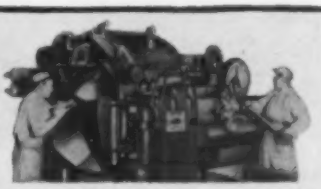
Previously, the highest interrupting rating known for circuit breakers was 15,000,000 kva and the first breaker with this 15,000,000 kva rating is scheduled to be completed by General Electric's switchgear department this month. The highest rated breakers now in service are 10,000,000 kva and the first of these were also manufactured by General Electric.

PRECISION GRINDER

▲ Hanchett Manufacturing Co. announces a new Model "DN" low-priced, precision knife grinder, featuring a new automatic table drive transmission developed exclusively for this type and size of machine which incorporates the very latest design timing belt drive. The manufacturer states that this drive is positive, quiet, non-slipping and eliminates a complete train of gears, which drive minimizes wear — due to less moving parts and requires no lubrication whatsoever. This drive is entirely free from vibration, chatter reversal shock. The rack pinion shaft is carried on roller bearings and the idler shaft on precision ball bearings, which definitely insure perfect alignment, rigidity, and extremely quiet and smooth table operation.



The new precision knife grinder features forced feed lubrication to table ways. The machine ways, both "flat" and "vee" are ground to precision tolerances on a specially developed Hanchett Heavy Duty Way Grinder. After grinding, the ways are lapped and then carefully hand scraped by specially trained men to provide the proper voids for an



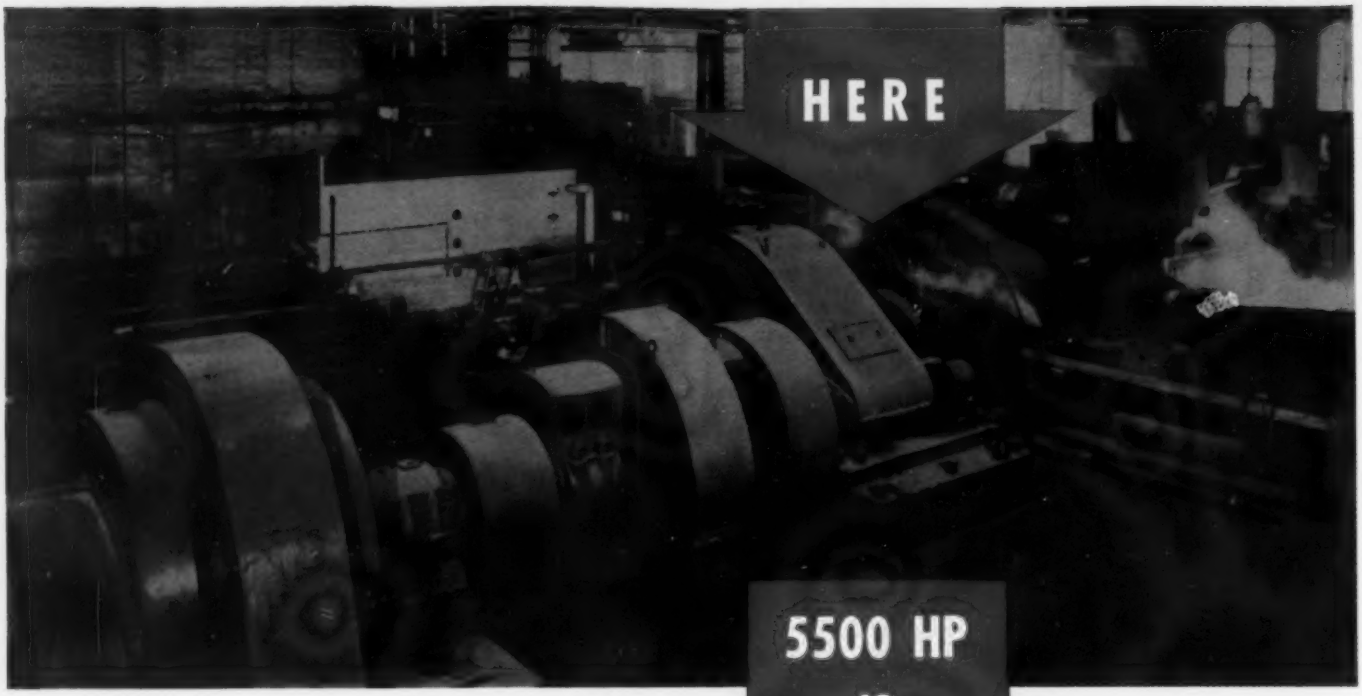
"THIS LUBRICANT INCREASED BEARING LIFE FROM 2 WEEKS TO 2 YEARS"

—says THE GLOBE COMPANY

"Animal acids and moisture, most harmful to ball and roller bearings prevails in the entire meat packing industry. With conventional lubricants, some of the bearings in our Roto-Cut machines did not last two weeks. Since using Ball Bearing LUBRIPLATE in machines operating continuously 24 hours a day for over two years, we have not had a single bearing replacement."

For nearest LUBRIPLATE distributor, see Classified Telephone Directory. Send for free 56-page "LUBRIPLATE DATA BOOK"... a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.



5500 HP IS FOLLOWING THE PATH OF LEAST RESISTANCE

Because of their specialized design and high-precision gears, Farrel® gear units offer a minimum of resistance to the smooth flow of power from motor to mill.

The gears are precision generated by the famous Farrel-Sykes process. This method of generation assures extreme accuracy of tooth spacing, contour and helix angle, which results in high efficiency and quiet operation.

In this installation, the Farrel unit is transmitting 5500 HP to a 134", 3-high sheared plate mill, reducing the motor speed from 375 to 70.35 RPM.

Send for information on reduction gear drives, pinion stands, or combination units for specific applications. Or, if you prefer, our engineers will be glad to discuss gear drive problems with you at any time, without obligation.

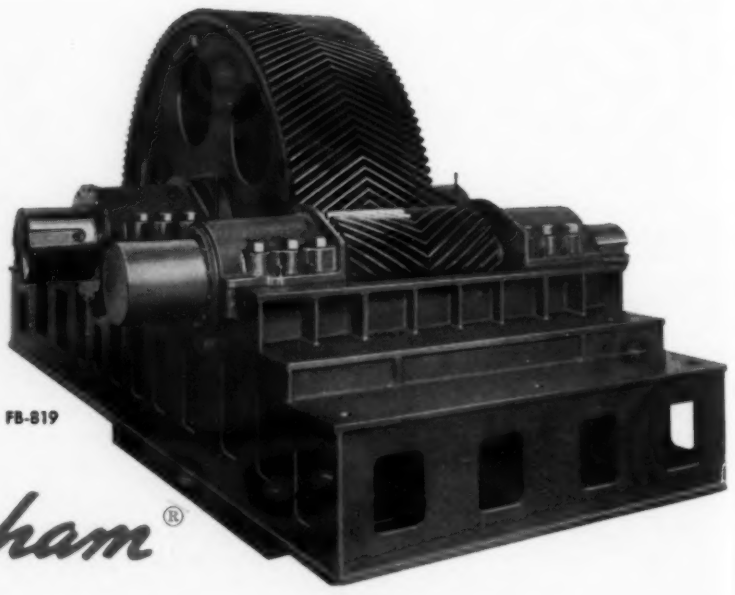
•

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

FARREL ROLLING MILL MACHINERY

Rolls • Rolling Mills • Mill Tables and Manipulating Equipment • Universal Mill Spindles • Rod Coilers • Gears • Mill Pinions • Pinion Stands • Gear Drives of Any Capacity • Flexible Couplings • Roll Grinding Machines • Roll Calipers



FB-819

Farrel-Birmingham®

oil film on the ways. This definitely makes possible the smoothest running table carriage operation, entirely free of vibration and shock, which is characteristic of all Hanchett knife grinders.

All base castings, fabricated steel bases and parts are subjected to an exclusive normalizing treatment. In a large specially developed oven, that can hold 30,000 lb of material per charge, the castings are gradually heated to a temperature approximating 1200 F. The parts then are allowed to cool off slowly to normal temperature. This treatment relieves all internal strains and stresses, rendering the bases completely inert. Through this most modern normalizing process, bases and parts take a final "set" and remain unaltered for the life of the machine. Thus, because bases and parts are permanently stabilized, the precision which is so painstakingly built into all Hanchett machines, remains as a constant factor, insuring accuracy of work ground with finest finishes of knife edges at all times.

FREE-MACHINING STEEL

▲ Jones & Laughlin Steel Corp.'s new free-machining open hearth steel was developed to serve the screw machine industry. That industry is composed of jobbing shops which use automatic lathes called "screw machines" to produce small metal component parts.

Screw machines themselves have been greatly improved in the last 20 years. They are faster and more accurate. Average cutting speeds and feeds have increased two to three times since 1930. Tooling is better.

On a simple setup, a machine might produce as many as 6000 parts per hr. More complicated parts might take 2 or 3 min to machine.

An estimated 4000 screw machines are in use today. These machines are a far cry from the original machine which made its appearance in the early 1880's.

That first machine had actually been designed to produce small standard screws and studs. As applied to a modern high speed automatic multiple spindle machine, the term "screw machine, is practically a misnomer.

Today's versatile machines, equipped with automatic devices, still turn out special screws, nuts, studs. But the great bulk of their output is in

AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

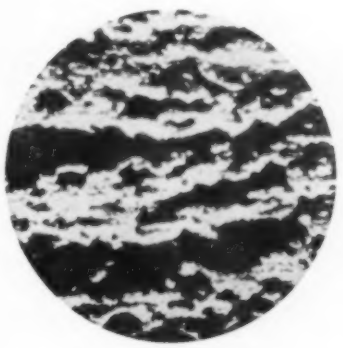
Technical Service Data Sheet

Subject: EFFICIENT PICKLING WITH RODINE®

ADVANTAGES OF "RODINE"

RODINE is used in sulfuric and muriatic acid baths for improved pickling and increased production. It meets Government Specification U.S.N. 51-I-2.

In straight line pickling of wire, rod and tubing, RODINE makes available more metal for drawing by protecting steel from acid attack. In batch pickling of sheet steel, RODINE improves the surface. In rapid, continuous strip pickling, RODINE not only saves acid and metal, but also prevents over-pickling during line shutdowns.



◀ *This steel surface was pickled in an uninhibited acid bath. Note the deep pits, and that the surface is visibly crystalline.*

This surface was pickled exactly like the one above except that "RODINE" was added to the acid solution. Only scale pockets and roll marks are visible; no pitting occurred. ▶

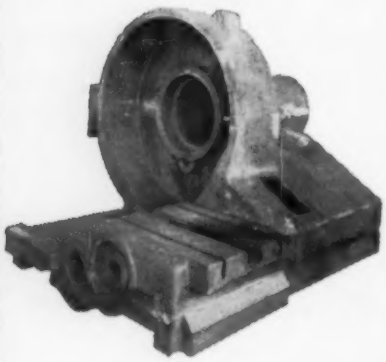
CHEMICALS ACP PROCESSES

WRITE FOR DESCRIPTIVE FOLDER ON "RODINE" AND INFORMATION ON YOUR OWN PICKLING PROBLEM.

CHEMICALS ACP PROCESSES

Hyde Park
RED CIRCLE Rolls ALLOY-CHILLED
Gray Iron Castings

Castings of any size up to 80,000 pounds. Hyde Park facilities are equal to your every requirement



Machine Castings
Lathe Beds
Housings
Pinion Housings
Mill Housings
Shoe Plates
Layout Plates
Surface Plates

Hyde Park
FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland County, Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

small intricate parts knocked out in fabulous quantities. Standard screws, bolts, studs and the like are manufactured on cold heading machines.

To get these properties in high production screw stock, Jones & Laughlin metallurgists combined the carefully controlled chemistry of an open hearth steel with cold drawing. The result is the recently announced J&L "1200" series of free-machining steels.

The first heats or batches of experimental steel were made in May, 1951 in J&L's pilot open hearth furnace at the metallurgical research laboratory. These heats were then rolled to bar sizes, cold drawn and tested in automatic screw machines.

In July, 1951, the first production trial heats were made in the open hearths at J&L's Pittsburgh, Pa., works. The first heat was 65 tons. The second was 175 tons.

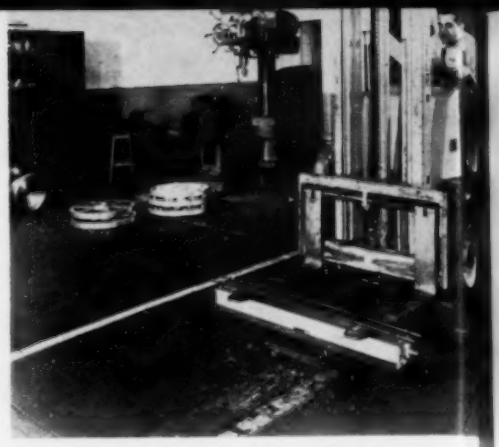
Other heats of "1200" steel were made during 1951. The steel was thoroughly tested in J&L's chemical and metallurgical laboratories. Many bars were shipped to customers for trial in screw machine production setups.

MAGNETIC ROAD SWEEPER

▲ A new magnetic road sweeper, designed to remove tacks, nails and other tramp iron from parking lots, factory aisles and airports, has been developed by the Eriez Manufacturing Co. Called the "Super-Sweeper," it can be pushed, pulled or suspended, and is made in three strengths and four widths: 24 in., 36 in., 48 in. and 60 in. sizes. Entirely new, fast cleaning principles make the sweeper a natural for cleaning even the largest areas in a short period of time.

The handle is of tubular steel which is easily removed for storage and transportation. The Super-Sweeper's powerful Alnico V magnetic element will snap up and hold tramp iron which comes in its path. A loop at the end of the steel handle can be attached to almost any trailer hitch. The wheels are fitted with puncture-proof 8.00 in. × 2 in. tires. Heavy-duty models operate efficiently at speeds up to 10 miles per hr.

By removing the wheels and handle, and attaching with built-in eyebolts, the sweeper is quickly adapted for use on industrial life trucks. It has a square aluminum cover, the ends of which are closed with sturdy aluminum castings. The entire element is



Designed to remove tramp iron from parking lots, factory aisles, and airports, this sweeper covers a large area in a short period. It can be quickly adapted for use on industrial lift trucks, and can be pushed, pulled, or suspended for various operations.

securely riveted together. Attached to each side of the magnet's face is a stainless steel deflector which serves to prevent damage to the face if large objects are encountered. The sweeper is quickly cleaned by turning the magnetic face up with the handle and stripping metal accumulation from the canvas cover.

TRIMMING PRESS

▲ Development of a new line of trimming presses, featuring the streamlined box-type crown construction, is announced by E. W. Bliss Co. These presses are especially designed for rigidity and quietness of operation.

The single-geared presses in the line are of four-piece frame welded steel construction with twin herringbone driving gears running in oil and equipped with rim-type, oil tight gear guards.

Among the features of the new trimming press are an air counterbalance concealed in the uprights, automatic lubrication and the Bliss fast-acting, cool-running friction-type clutch. Another important feature of this press is the friction clamp slip-type knockout which prevents accidental breakage of dies, or other parts, by permitting the friction clamp to slide on the knockout bar whenever the bar has not been adjusted to the proper height.

The press operates at a speed of 35 strokes per min with ram capacity of 440 tons. The slide has a 16-in. stroke with a motorized adjustment of 6 in., and the trimming attachment has a 10-in. stroke with a 4-in. adjustment. The press is 18 ft high, has floor space requirements of 94 in. × 86 in. and weighs approximately 98,000 lb.

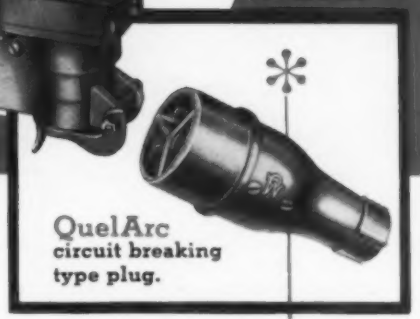
Heavy Duty Safety Switch, and Circuit Breaker

RAIN-TIGHT! DUST-TIGHT!

RAIN-TIGHT SAFETY SWITCHES with receptacle, fusible or fuseless, ratings up to 100 amps. 600 volts . . . without receptacle, up to 200 amps. 600 volts. (NEMA TYPES V, IV and III)

DUST-TIGHT AND RAIN-TIGHT CIRCUIT BREAKERS with receptacle, ratings up to 100 amps. 600 volts . . . without receptacle, up to 225 amps. 600 volts. Dust-tight types for hazardous locations, Class II, group E, F, and G. (NEMA TYPES IX, V, IV and III)

PYLETS



QuelArc circuit breaking type plug.

Designed for Safe, Reliable Operation and Protection of Portable and Stationary Electrical Equipment, indoors and outdoors, under the most severe operating conditions

MUCH LONGER SERVICE LIFE AND LOWER MAINTENANCE COSTS insured by heavy, rust-resisting cast metal construction and rain-tight gasket seals.

COMPLETE SAFETY FOR THE OPERATOR is provided by safety circuit grounding and the interlocking of door and plug receptacle with a quick make and break switch mechanism.

Consult your Pylet Catalog, Bulletin 1150 for complete listings.

PYLE QuelArc plugs, used with this equipment, are well known industrially, for their unique partitioned construction. Long insulating surfaces from pole to pole, and from poles to ground provide for exceptionally safe handling and long service life.

SINCE 1897

THE PYLE-NATIONAL COMPANY
1383 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS

District Offices and Representatives in Principal Cities of the United States
Export Department: International Railways Supply Co., 30 Church St., New York.
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PLUGS AND RECEPTACLES • FLOODLIGHTS • TURBO-GENERATORS • GYRALITES • CONDUIT FITTINGS • MULTI-VENT AIR DISTRIBUTION

NICAD

MADE IN U.S.A.

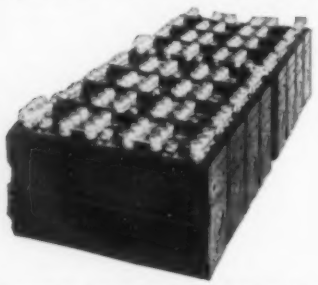
T-TYPE BATTERY

for

RAILROAD

DIESEL STARTING

2 models—THR-30, THR-44



SAVES UP TO 100 MAN HOURS PER YEAR PER LOCOMOTIVE

Because the NICAD nickel cadmium storage battery requires less maintenance you save precious man hours and, at the same time, are assured of reliable, foolproof battery service throughout its long life. The T-Type NICAD battery has an exceptionally high ampere rate of discharge at useful voltage, a vital consideration in engine-starting applications.

BATTERY TYPE	AMPERE HOURS	NUMBER OF CELLS	GROUP TRAY LENGTH A	TRAY WIDTH B	WEIGHT LBS.
THR 30	142	48	33¾"	9"	1825
THR 44	210	48	44¾"	11"	2575

THR-30—Interchangeable with 17-plate, 248 A.H. Lead Acid Batteries
THR-44—Interchangeable with 25-plate, 426 A.H. Lead Acid Batteries

NICAD IS LIGHTER, NEEDS NO ADDITIONAL SPACE

Exceptionally Long Life — *Low Internal Resistance*
Low Cost Operation — *Rugged Steel Construction*
Negligible Water Consumption — *Very Low Self-Discharge*
Uses Standard Charging Equipment

Other NICAD Applications in:

UTILITIES HEAVY AUTOMOTIVE
MARINE RAPID TRANSIT
LABORATORIES

NICAD

NICKEL CADMIUM BATTERY CORPORATION
100 Park Ave. New York 17, N. Y.

Factory—Easthampton, Mass.
Chicago Office—100 N. La Salle St.

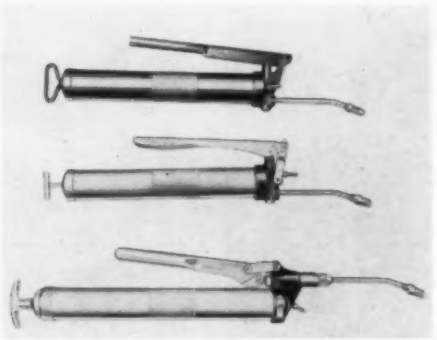
•

MADE EXCLUSIVELY IN THE USA

GIANT GREASE GUN

▲ Lincoln Engineering Co. has designed and is marketing four new giant-size lever-type grease guns. These guns hold 40 to 100 per cent more lubricant than ordinary grease guns.

The manufacturer states that just a few shots of grease lubricates most bearings, no stopping to refill guns, no hose to drag, tangle, or get in the way. Guns can be refilled in seconds from a Lincoln filler pump, no mess or waste. Guns may also be filled by suction.



Four models are available: two 21 oz capacity guns developing 10,000 lb pressure; a 32 oz capacity gun — 10,000 lb pressure; and a 32 oz capacity volume-type gun, developing 4300 lb pressure. All models include long hydraulic coupler extension for ease in contacting hard-to-reach fittings, and filler nipple for refilling guns from a filler pump.

LEAK DETECTOR

▲ A nearly fool-proof method of finding leaks has been developed with a gas that once served only as the cold-making agent in refrigerators.

The new test medium is Du Pont "Freon-12" fluorinated hydro-carbon which, under pressure, is a colorless, virtually non-toxic and odorless liquid, but which changes to a gas when released from pressure at room temperatures. Its use as a leak detector stems from its ability to seek out and escape through the finest openings in almost any material. The exact location of such leaks can be found quickly with an electronic device or a gas-burning torch whose flame changes color in contact with the non-flammable chemical.

Halide torches, small hand-held lamps in which methyl alcohol, acetylene, or propane burns with an almost invisible flame, have been used for many years to detect leaks of "Freon" in refrigeration systems. The sensitive flame turns green or blue-green in the presence of the gas, and experts can tell by the flame color just how big the leak is.

A more recent development is the electronic leak detector which is responsive to "Freon" or other gaseous halogenated compounds. The first of these offered for sale was developed by General Electric. Weighing only 17 lb and approximately the size of a small portable typewriter, the General Electric unit is so sensitive that engineers say it can uncover a leak that would let only 1/100 oz of "Freon" escape in a year.

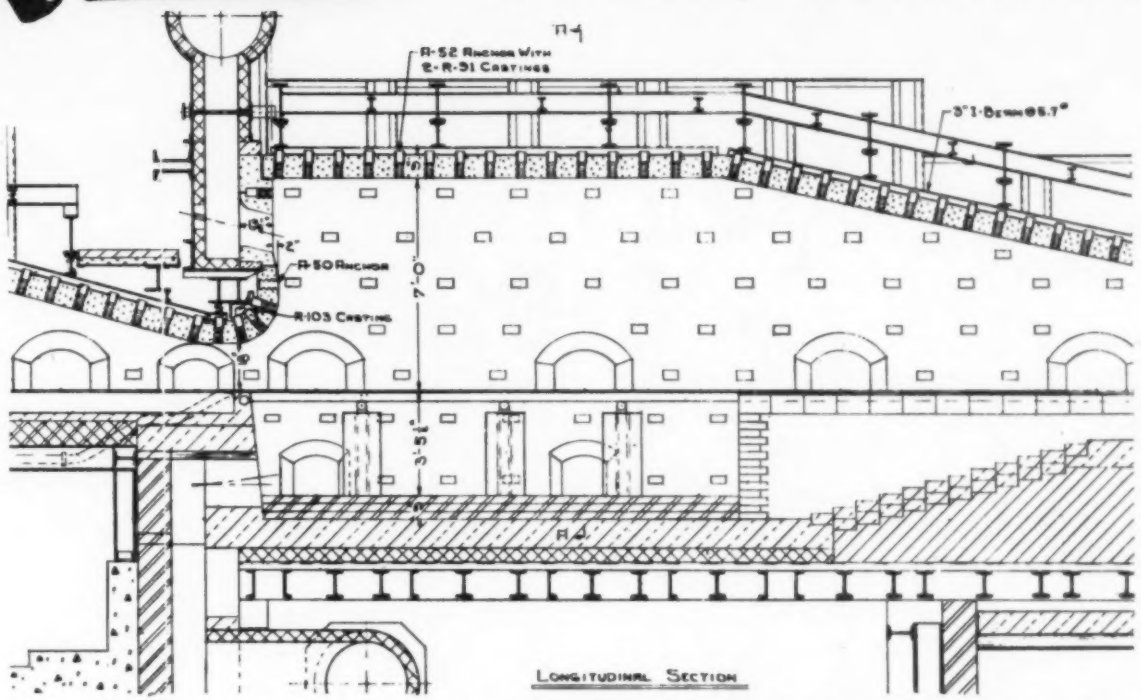
Western Electric is supplying a "traveling detective" version of the electronic tester. This instrument is pulled along on overhead telephone cables and signals leaks which, if not detected and cleared, might impair telephone service.

To perform at top efficiency, most telephone toll or long-distance cables are filled with nitrogen or air under pressure and then sealed, thus keeping out moisture and providing an inert atmosphere for the maze of wires within the cable. To locate leaks which cannot be found economically by other means, "Freon-12" fluorinated hydrocarbon is pumped into the cable to displace the nitrogen or air. The electronic tester, sensitive to

This 48-ton armature — now in production at the East Pittsburgh, Pa., plant of the Westinghouse Electric Corp. — gets a final inspection before being shipped to the Alton, Ill. plant of the Laclede Steel Co. It stands 10 ft high and has an 18 ft long shaft. As part of a revamp job, it will be the rotating component of a 5000-hp, 60/150-rpm blooming mill motor that will replace an outdated steam drive.

Ramtite

an effective solution to simplicity of refractory construction



CONTINUOUS TRIPLE FIRED REHEAT FURNACE

An outstanding demonstration of the flexibility of RAMTITE construction. Only two refractories, RAMTITE Plastic Refractory and the Safe-Tie Anchor, were used to construct the flat roof, sloping roof, knuckle nose, burner ports and sidewalls

An important property of Ramtite is its ability to retard the flow of heat through the refractory lining. This, plus the permanent gas tightness of the monolithic structure, results in greatly reduced heat loss. Users of Ramtite lined heating furnaces for slab, bar and merchant mills have reported appreciable fuel savings, increased production and longer refractory life. Ramtite men are always available for consultation.

Send for your FREE copy of our new catalog "STEEL PLANT FURNACE CONSTRUCTION."

THE RAMTITE COMPANY
DIVISION OF THE S. OBERMAYER COMPANY
1813 S. ROCKWELL STREET, CHICAGO 8, ILLINOIS

RAMTITE®

PLASTIC AND CASTABLE REFRACTORIES

17% fuel saving!

and a 3-month write-off!

with BLOOM Ka-Weld PRECAST REINFORCED Pipe Insulation

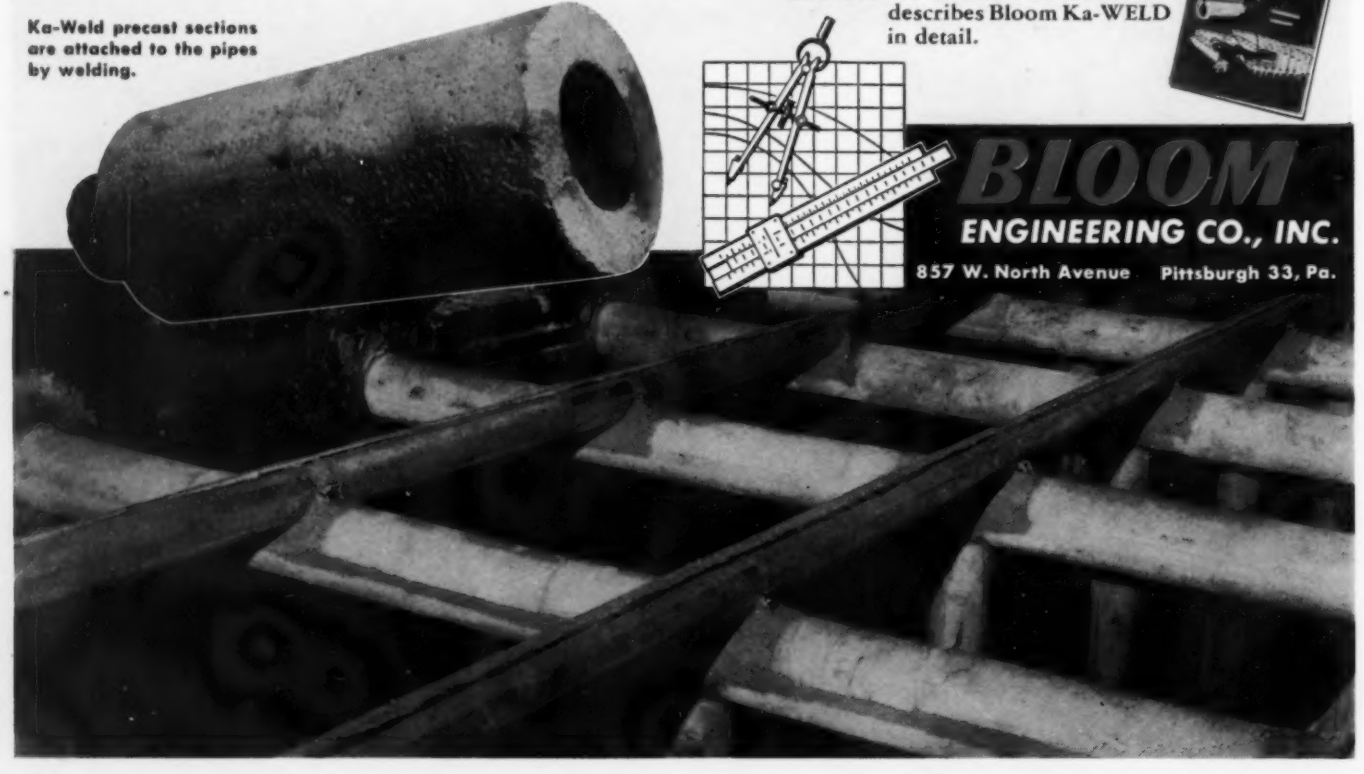
A midwestern plant reports an overall fuel savings of seventeen per cent, attributed to Bloom Ka-WELD installed on water-cooled support pipes of a strip mill furnace. As a result, complete write-off was obtained in *three months!*

Made of durable, readily-applied refractory material, Bloom Ka-WELD increases furnace output, reduces the heat-loss to cooling water, permits more uniform heating of steel due to increased bottom zone temperatures, prolongs skid life, reduces skid marks, slagging and sticking, saves water.

Such results, coupled with Bloom's one-year guarantee, make Ka-WELD an excellent investment.

Send for bulletin 2183, which describes Bloom Ka-WELD in detail.

Ka-Weld precast sections are attached to the pipes by welding.



BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

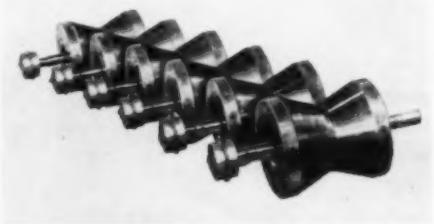
"Freon" and riding the cable suspension strand like a monorail car, is pulled along the cable. When the "Freon" detector spots a leak, a signal is transmitted to the ground crew and repairs are made quickly and surely.

Before the electronic "sniffer" was developed, one of the methods used to find telephone cable leaks consisted of painting the cable with soap solution so gas escaping through a defect would show up as bubbles. That was a long, tedius job. The new electronic device and "Freon" permit faster inspection of cable at a money-saving rate of about 120 fpm.

Another use is in the testing of complicated pipe coils or pressure vessels too large and cumbersome to be filled with compressed air and dunked in a liquid bath where escaping bubbles would indicate leaks. Today, such precision manufacturers as Foster Wheeler Corp. carry out tests on tanks as high as a two-story building by filling them with a mixture of "Freon" and air, then carefully inspecting likely leak points, such as joints, fittings, or welds, with one of the electronic "noses."

NON-ELECTRIC ROLLS

▲ Non-electric concave and straight magnetic rolls with extremely high surface strength are designed to cut time and labor costs of handling pipe, rods, angles, flat sheets, plates, bars, etc. Rolls use no current, require no



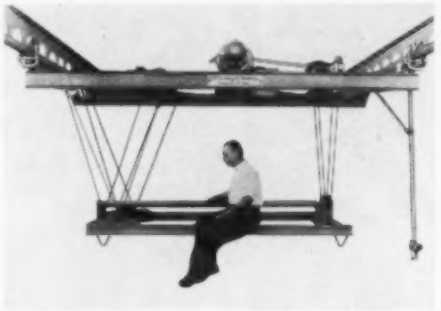
wiring and only a minimum maintenance. Their magnetic strength is certified, guaranteed permanent for the life of the unit by Dings Magnetic Separator Co.

Rolls for conveying pipe, rods, angles, etc., are concave in shape to keep pipe material centrally located. Rolls for handling flat material are straight faced.

STABILIZED CRANE

▲ A new "Tramrail" stabilized crane which eliminates the usual swinging of a load being hoisted or transported from one area to another has been developed by the Cleveland Tramrail division of Cleveland Crane & Engineering Co.

Elimination of load swing is of tremendous help in speeding tank-dipping operations such as anodizing, chromodizing and similar plating operations. It is an aid in various assembly operations since parts or assemblies being worked on can be held solidly in position. The no-swing feature is also advantageous for sup-



porting traveling x-ray equipment used for making studies of long objects. It makes possible the delivery of hot metal in a foundry by an automatic dispatch method direct from cupola to molding area.

The crane has a simple arrangement of hoisting ropes which form a triangular suspension. This permits a load to be held rigidly in place so as to eliminate longitudinal, lateral and rotational sway. Thus, a load can be raised or lowered through a considerable distance and yet with nothing more than the hoisting ropes supporting it, will remain as rigid as if guided in an elevator shaft.

PLASTIC LABEL TAPE

▲ Shelves, bins and drawers for tools, dies, parts, inventory and raw stock have always presented a labeling problem, as have many of the items stored. Card and paper labels become quickly soiled and hard to read. Gummed labels, as a rule, do not adhere well to many materials and finishes. If they fall off, endless confusion and lost time result.

Recently an entirely new kind of plastic labeling tape has been developed which solves this labeling problem perfectly. The new tape, known as "Labelon," is of the so-called "pressure-sensitive" type and sticks without moistening to any smooth, dry and reasonably clean surface. Labelon can be written on without ink, pencil or crayon — all that is needed is a sharp point. A pencil is ideal, and usually the handiest, but a stylus is perfectly satisfactory and even a shingle nail will do in a pinch.

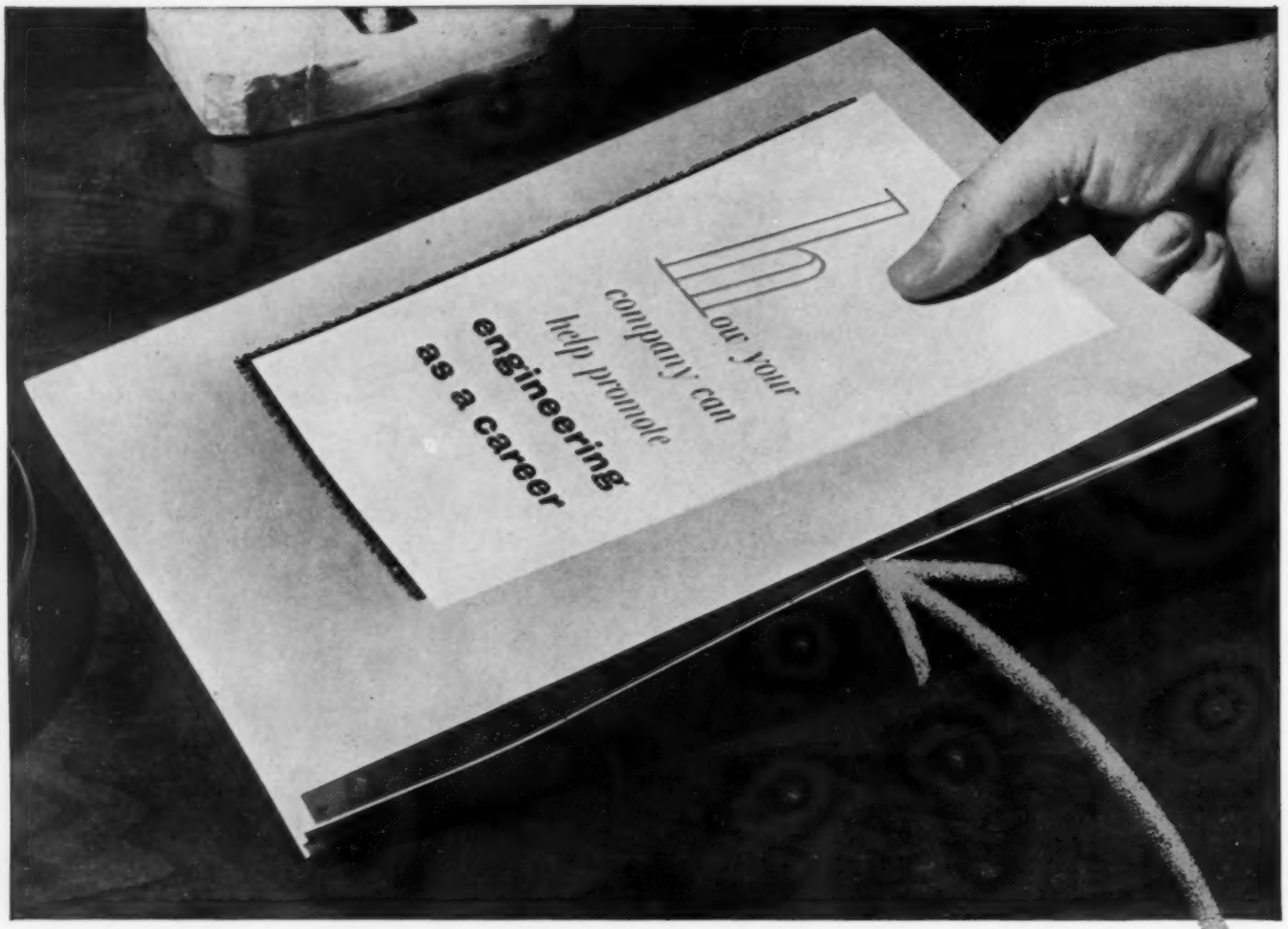
Pressure of the writing instrument alone causes the writing to appear beneath a protective outer coat of transparent plastic. This transparent outer coat protects the writing against smudging, oil, grease, water, most chemicals and dirt. It may be wiped clean in a jiffy should dust settle on it. Neither Labelon's adhesive qualities nor the legibility of writing on it are affected by temperature changes between —40 and +150 F. The tape will not curl, discolor or lose its adhesive quality due to age.

Writing on the tape appears in a strong contrasting color on a gleaming white background, very easy to read against the drab finishes usually used for shelving, bins, drawers, etc., or against steel, brass, aluminum, plastic and other raw stock materials.

In order to make the new tape stand out even more strongly against dark backgrounds, narrow bands of the same color as the writing are carried at top and bottom of the strip.

Available color combinations include blue and white, red and white, and green and white, thus providing a ready means of coding if desired. Many lengths and widths are also available, most sizes held in a handy plastic dispenser with an efficient serrated edge cutting bar. The larger rolls, on 3-in. cores, fit standard heavy duty dispensers.

Development of a "pressure-sensitive" type of tape that sticks without moistening solves the problem of labeling shelves, bins, tools, and raw stock. Pressure of a sharp point causes writing to appear beneath a transparent plastic coating which will not be affected by temperature changes.



HERE'S HELP

for your engineer-recruitment problem

Engineers' Joint Council and The Advertising Council offer free, expert help to advertisers promoting engineering as a career.

The booklet reproduced here was prepared by The Advertising Council in cooperation with the Engineers' Joint Council to help you make your advertising work most effectively in recruiting engineers for the future.

1. It tells you what the problem is and the important part you can play in solving it.
2. It outlines the advantages of an engineering career to help your company develop advertising appeals.
3. It informs you as to the current activities of industry in the education and recruitment of engineers.
4. It offers specific suggestions as to what you can do (from present manpower).
5. It provides material that you can use in your own local and national programs.

Many advertisers are using this booklet today. They say that it helps in orienting their engineer-recruitment advertising to industry-wide recruitment programs.

Send for this Free campaign guide
Prepared by
THE ADVERTISING COUNCIL
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JUST MAIL THIS COUPON!

The Advertising Council, Inc.
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Gentlemen: Please send me a *free* copy of *"How your company can help promote engineering as a career."*

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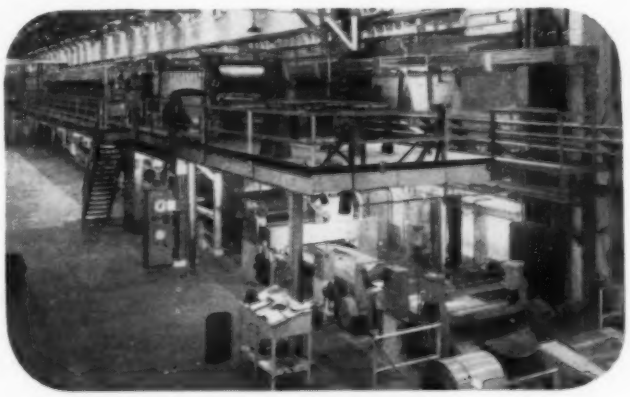
Galvanizing
Aluminizing
Bright Annealing and
Normalizing Strip ------ Continuously

Strip in single or multiple strands up to a total width of 54" may be bright annealed or normalized, continuously, in this EF gas fired radiant tube installation. Capacity 7200 lbs per hour.

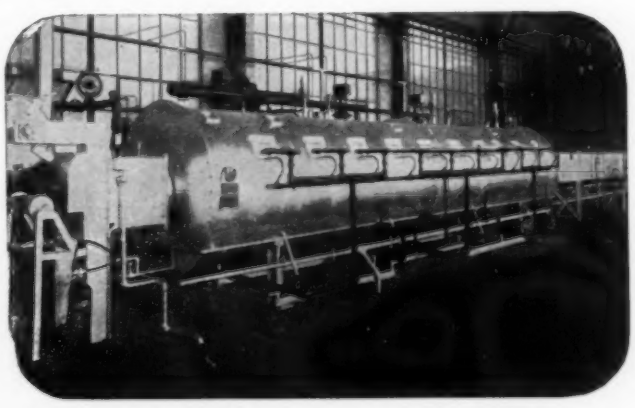


A large capacity continuous strip normalizing, annealing and galvanizing unit. This is a combination EF gas fired radiant tube and electrically heated installation and is over 400 feet long.

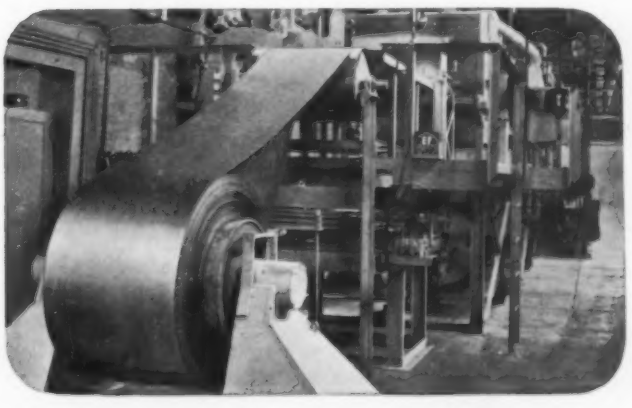
We are in position to design, build and put in operation; continuous strip lines for hot or cold rolled, high or low carbon, stainless, silicon, tinplate, aluminum, brass, bronze or any other ferrous or non-ferrous strip — for bright annealing, normalizing, galvanizing, aluminizing, tinning or any other process — in the size and type best suited to your plant, process, product or production requirements. No job is too large or too unusual.

Put your production furnace problems up to experienced engineers — *it pays.*

THE ELECTRIC FURNACE CO.
Salem, Ohio
Gas Fired, Oil Fired and Electric Furnaces
Canadian Associates • CANEFCO LIMITED • Toronto 1, Canada

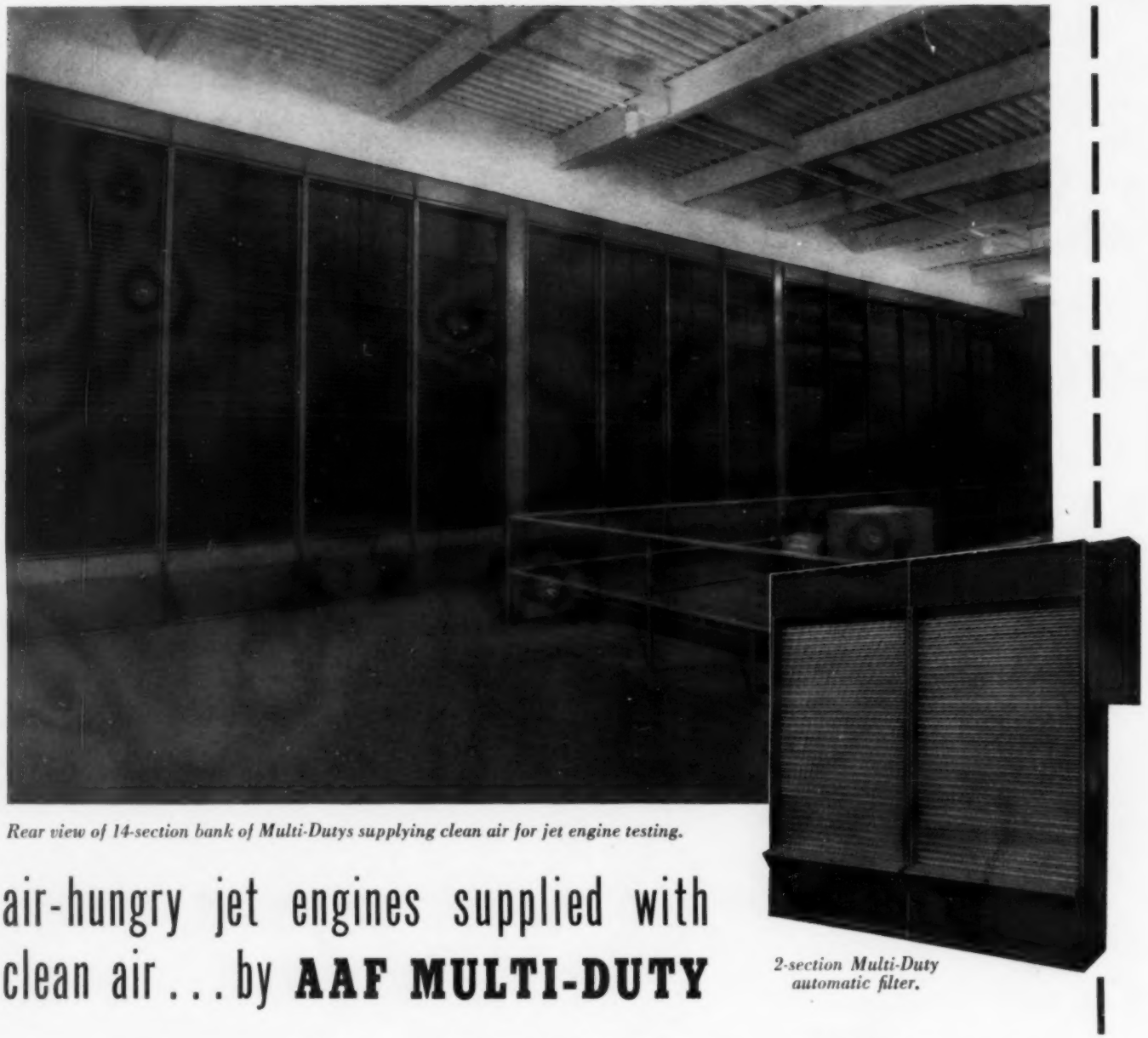


Stainless steel strip is bright or process annealed, continuously, in this EF gas fired special atmosphere tube muffle type furnace. It also handles other strip requiring lower temperatures.



An EF special atmosphere furnace with flame preheating burn-off or oxidizing section and controlled heating and cooling zones for producing various surface conditions on strip.

air as clean as you like it!



Rear view of 14-section bank of Multi-Dutys supplying clean air for jet engine testing.

air-hungry jet engines supplied with clean air . . . by **AAF MULTI-DUTY**

2-section Multi-Duty automatic filter.

Jet engines consume enormous air volumes. In factory test areas this air must be *cleaned* to protect the impeller blades and air foil surfaces.

The 14-section installation of AAF Multi-Duty Air Filters shown here is one of a double bank supplying *clean air* to the test area of a large jet engine manufacturer. The Multi-Duty is an ideal filter for this type of application where constant clean air volume is required. It is fully automatic and self-cleaning . . . assuring maximum operating efficiency at all times without dependence upon the human element. Also the exclusive principle of overlapping panel construction in the Multi-Duty has never been surpassed as the most practical method of combining the function of self-cleaning with the operating cycle. This AAF filter is used in many industries and is available in any size or capacity.

You may not manufacture jet engines. However, if *clean air* for test operations or precision processes is one of your problems, call your nearby AAF representative. His solution will be based on AAF's complete line of engineered air filters and thirty years experience supplying *clean air* to industry. Write for Multi-Duty Engineering Bulletin No. 241A.

American Air Filter
COMPANY, INC.

302 Central Avenue, Louisville 8, Kentucky
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®AAF

RUST-OLEUM®

STOPS RUST!

Resists Rain, Snow, Heat, Fumes, Weathering, Salt Water, etc.

Rust-Oleum *saves* preparation, *saves* manhours! Just scrape and wirebrush to remove rust scale and loose particles . . . then brush Rust-Oleum 769 Damp-Proof Red Primer *directly over the sound rusted surface*. Rust-Oleum finish coatings in many colors, aluminum, and white provide *double protection*. Specify Rust-Oleum for new construction, maintenance, or re-modeling. Prompt delivery from Industrial Distributor stocks in principal cities.

RUST-OLEUM CORPORATION
2444 Oakton Street, Evanston, Illinois

FREE SURVEY: Ask a Rust-Oleum specialist to conduct a survey including actual applications, tests, and recommendations. No cost or obligation. See Sweets for nearest Rust-Oleum distributor or write for literature today.

There is only one Rust-Oleum . . .

Distinctive as your fingerprint, Rust-Oleum is an *exclusive formula* created and developed by a Master Mariner during more than 20 years of battling actual rust-producing conditions at sea.

It incorporates a specially-processed fish oil vehicle that will *dry*, is *odor-free*, and is formulated in many *colors, aluminum*, and *white*. Specify genuine Rust-Oleum. Accept no substitute.

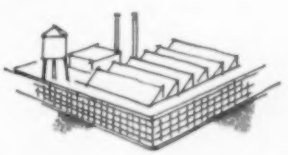
Practical, economical answer to your rust problems . . .

Sandblasting, chemical pre-cleaning and other costly preparations are not usually required as Rust-Oleum 769 Damp-Proof Red Primer may be applied *directly over sound rusted surfaces* after scraping and wirebrushing to remove rust scale and loose particles.

Brush, dip, or spray—available in many colors . . .

Beautify . . . as you protect with Rust-Oleum finish coatings available in a wide variety of colors. They incorporate the same basic rust-inhibiting vehicles and provide greater compatibility and *double protection*.

Proved throughout industry for over 25 years . . .



Leading companies throughout the world, in nearly every type of industry, have proved Rust-Oleum's capacity to resist rain, sun, snow, heat, fumes, salt water and salt spray, many acids and chemicals.

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RUST-OLEUM CORPORATION
2444 Oakton St., Evanston, Illinois

- ☐ Have a Qualified Representative Call
- ☐ Free Survey
- ☐ Complete Literature
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low cost heavy duty service with Foote Bros. MAXI-POWER

Costs go down when Foote Bros. Maxi-Power drives are installed! These rugged helical gear drives assure high efficiency — low maintenance costs — operate day after day, year in and year out without trouble and with minimum maintenance.

Precision-Generated Helical Gearing with uniform load distribution across the entire face permits maximum load carrying capacity in minimum space and assures the maximum in reliable, uninterrupted performance.

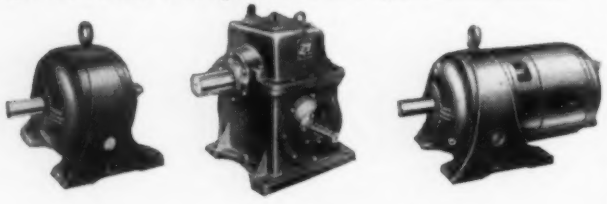
These drives are available in single, double and triple reductions, with ratios ranging from 2.08 to 1, up to 360 to 1. Capacities up to 1550 h.p.

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Blvd. • Chicago 9, Ill.

Maxi-Power drive at Murray Corporation of America, Ecorse Michigan Plant, driving tubular conveyor handling welding flux. Designed and manufactured by Hapman Conveyor Division of Hapman — Dutton Co., Kalamazoo, Michigan.

FOOTE BROS.

Better Power Transmission Through Better Gears



Foote Bros. Gear and Machine Corporation
Dept. IAS, 4545 S. Western Blvd., Chicago 9, Ill.

Please send Bulletin MPB containing full information on Maxi-Power Drives.

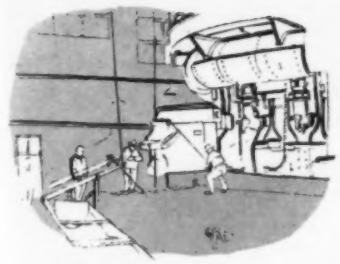
Name.....

Company.....

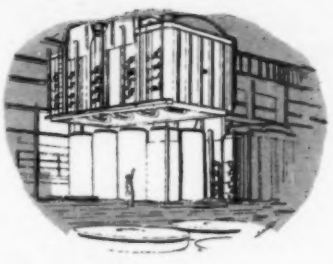
Position.....

Address.....

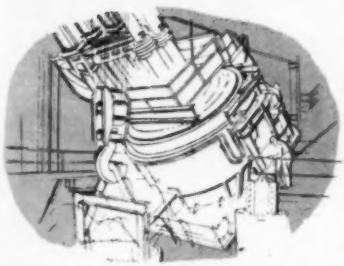
City..... *State*.....



BLAST FURNACE

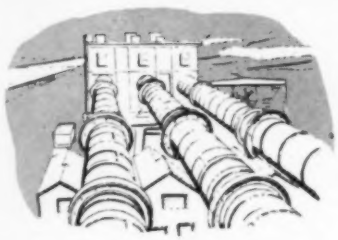


HEAT TREATING FURNACE

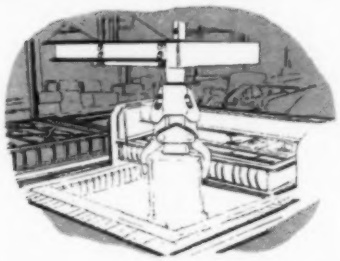


ELECTRIC FURNACE

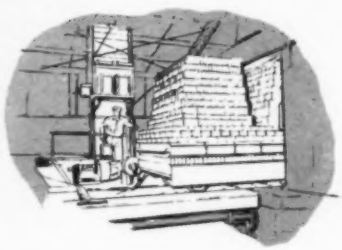
OPEN HEARTH FURNACE



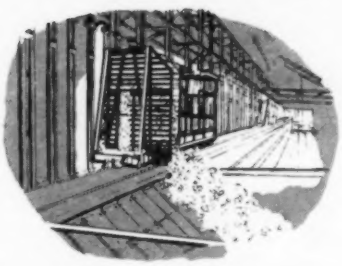
ROTARY KILN



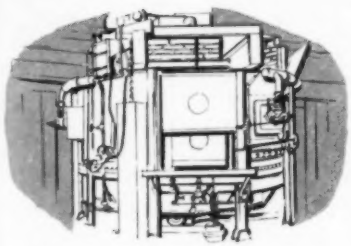
SOAKING PIT



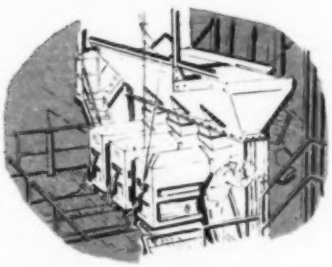
TUNNEL KILN



COKE OVEN



FORGING FURNACE



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From these can be selected the kinds and brands that will give longest life and serve most economically and efficiently in all furnace applications.

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1. Phone, wire or write to Savings Bond Division, U.S. Treasury Department, Suite 700, Washington Building, Washington, D. C.
2. Your State Director, Savings Bond Division, will show your company how to conduct a simple person-to-person canvass that will put a Payroll Savings Application Blank in the hands of *every* employee.

That is all management has to do. Your employees will do the rest. They, like the employees of the Erie Railroad, want to provide for their personal security and at the same time do their part in helping to keep America strong.

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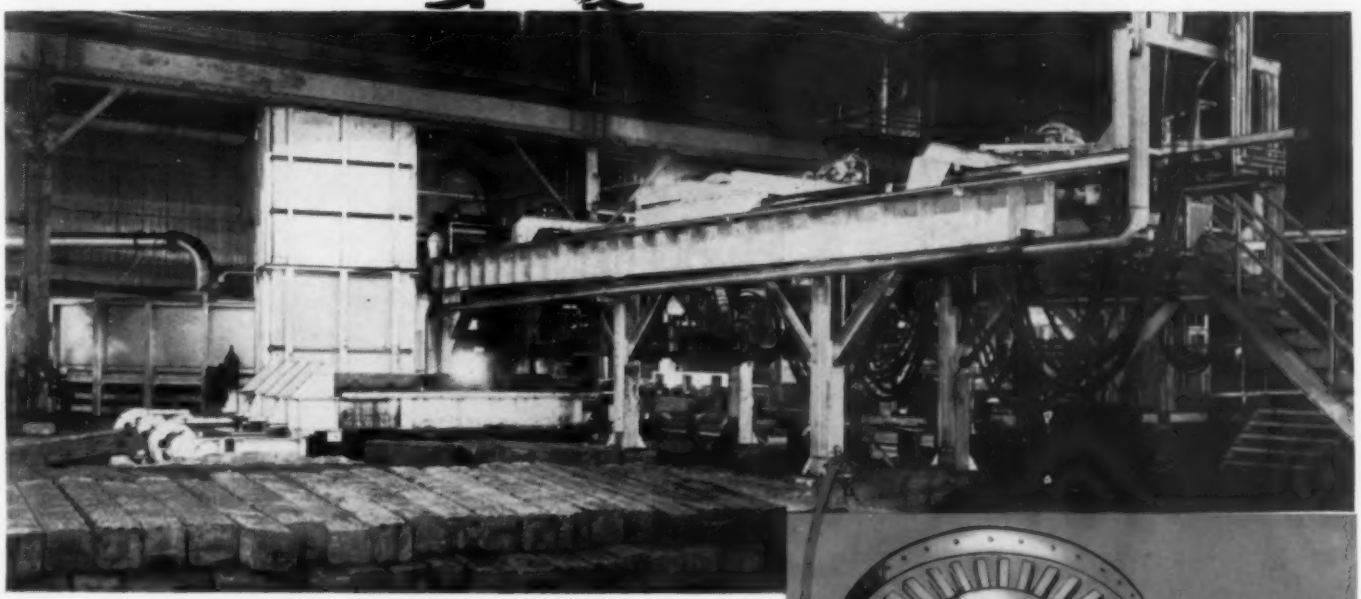
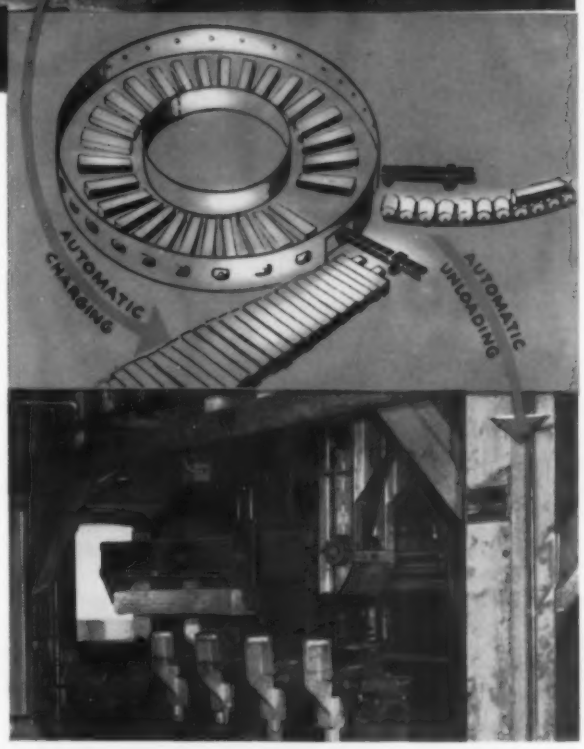
~~Water Cooling~~

~~Wearing Skids~~

~~Stickers~~

~~Dummy Steel~~





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. . . **ELIMINATE** water cooled supports and skids. Blooms are automatically loaded and unloaded from a refractory hearth.

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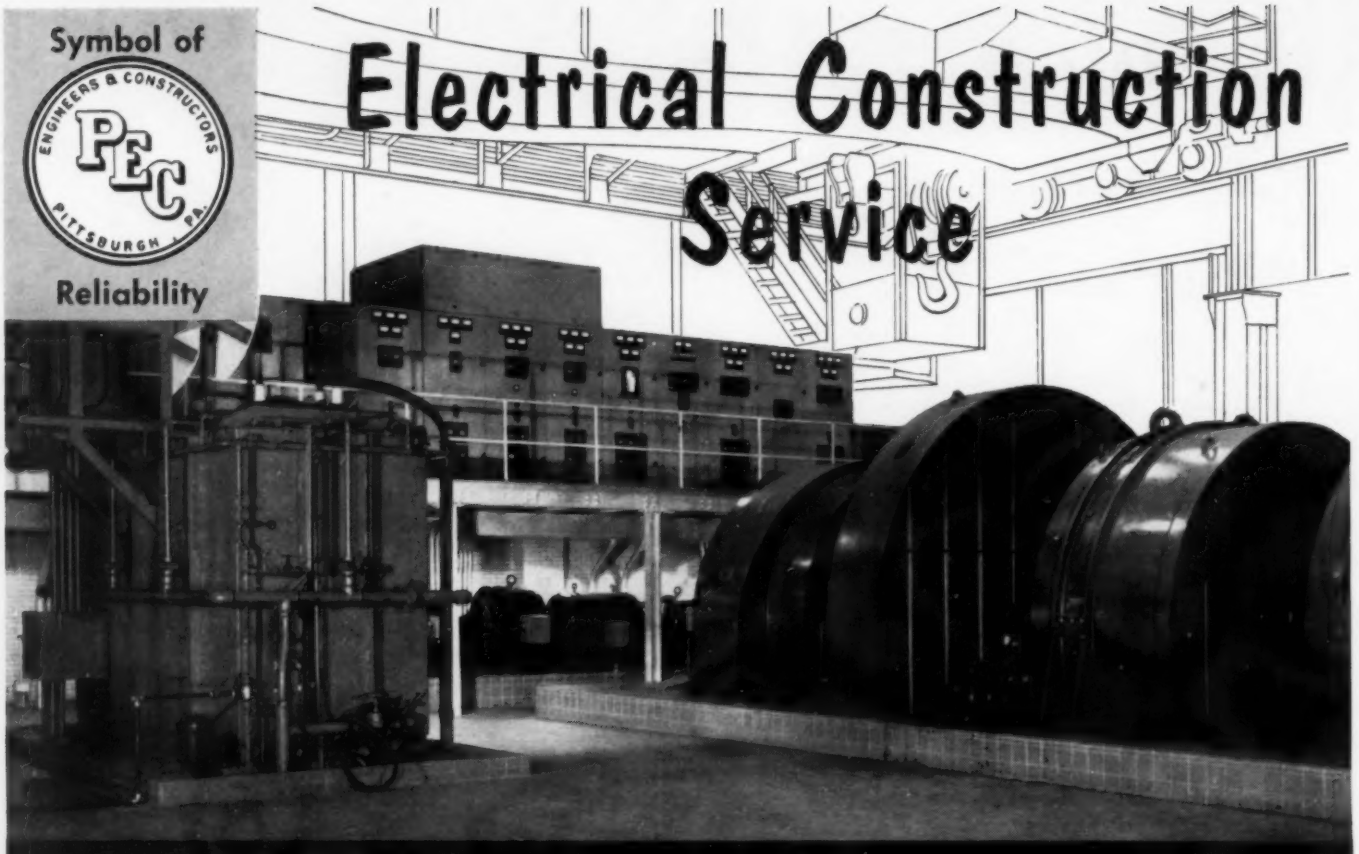

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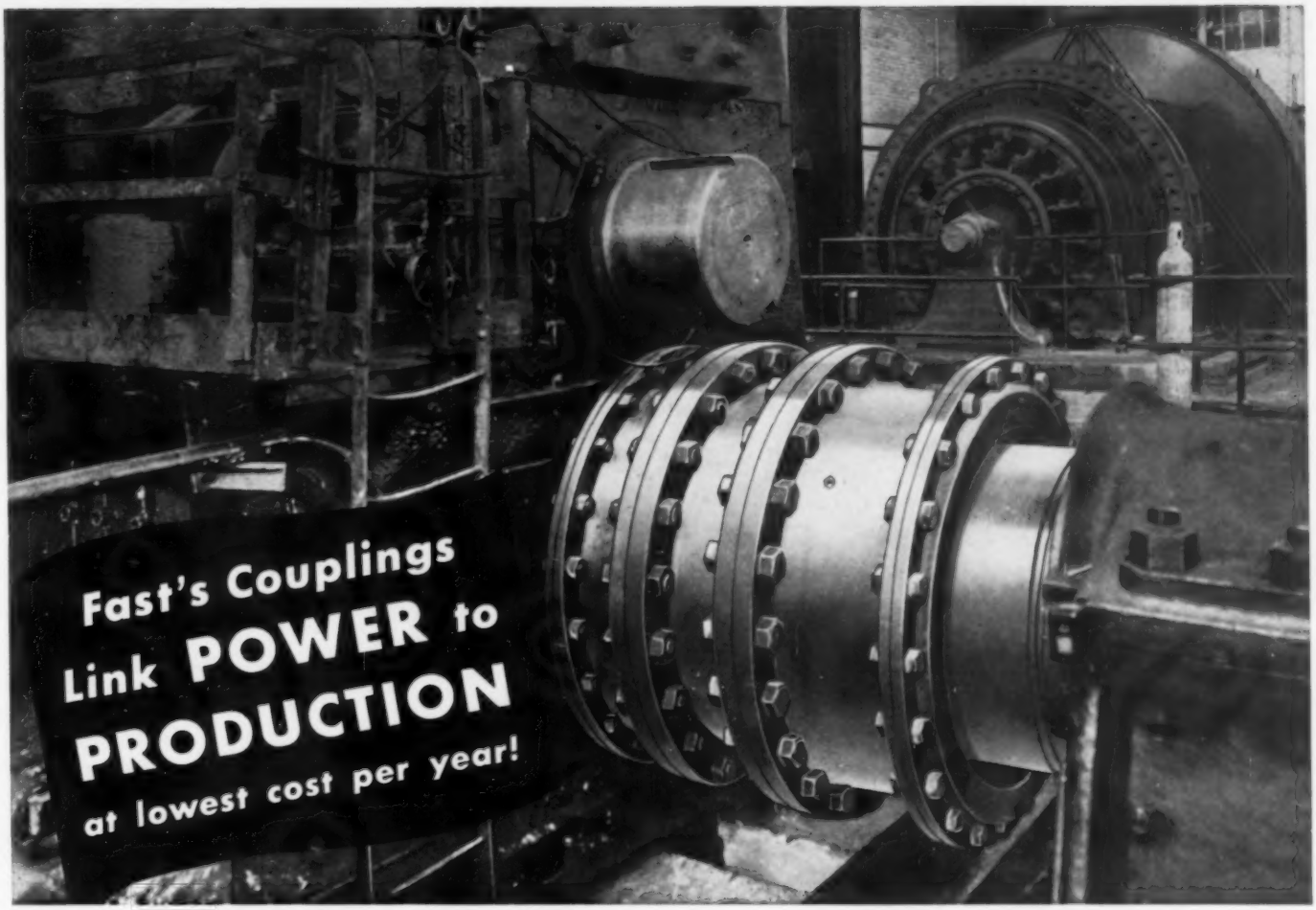

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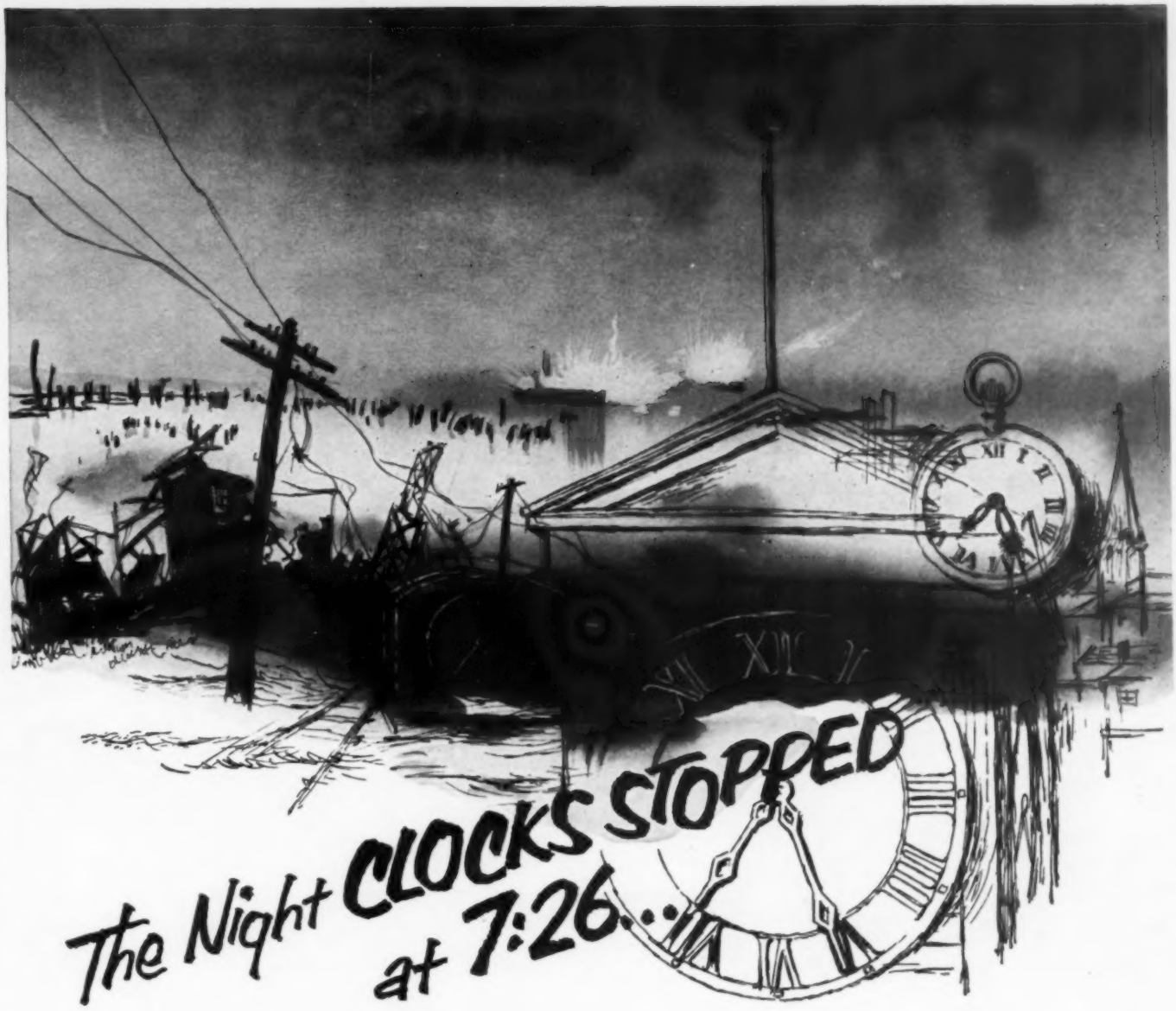

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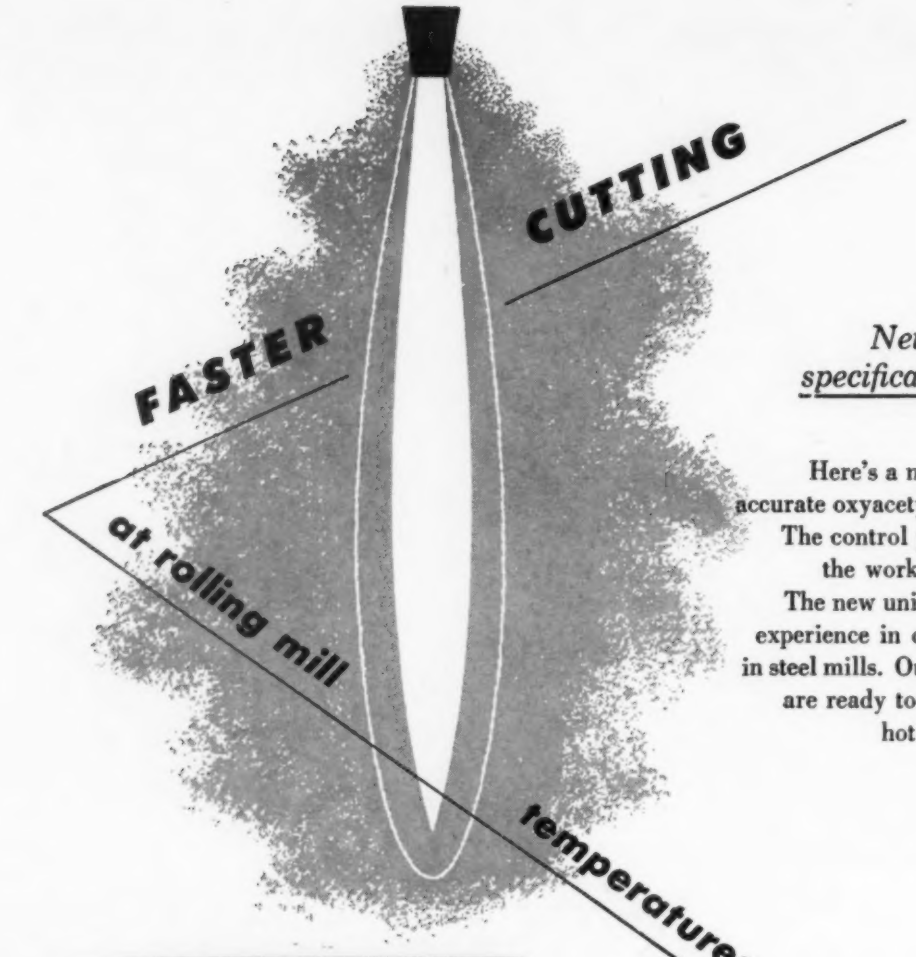

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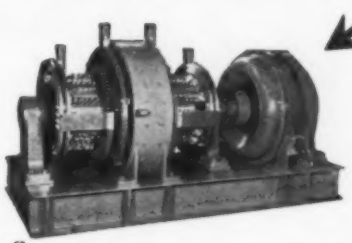

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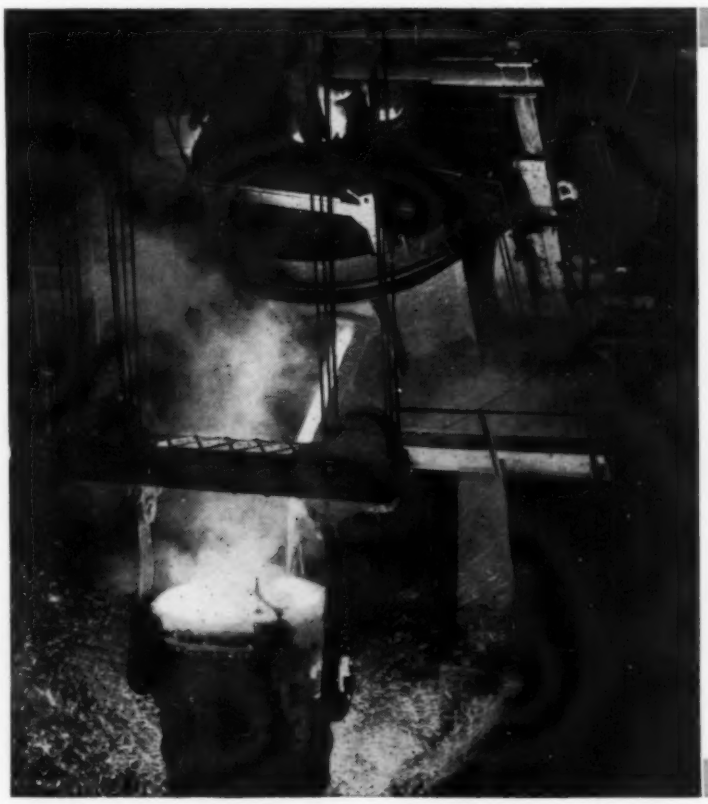

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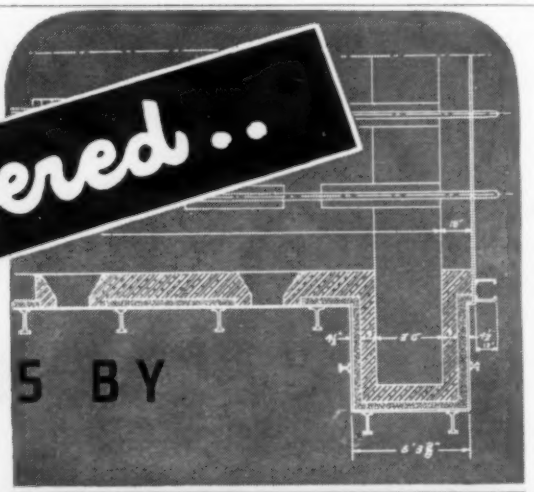

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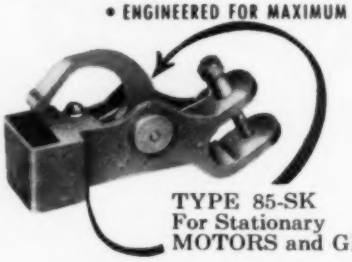

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Book Reviews . . .

▲ **"Control of Electric Motors,"** by Paisley B. Harwood, Cutler-Hammer, Inc., was recently printed in a third edition by John Wiley and Sons, 440 4th Ave., New York 16, N. Y., 6x9 in., 538 pp, cloth $7.50. Mr. Harwood's modern and enlightening coverage of the subject of control is refreshing and instructive. His angle of approach is aimed at readers within a wide spread of educational and experience levels. He departs from the usual stilted attitude of the average writer by going into painstaking and detailed explanation of construction of apparatus and its function and limitations in language easily understood by a technician of limited education without becoming boresome to the more highly trained engineer.

The author has freely extracted from (and liberally given credit to) published technical articles and manufacturers data. Many readers have much of this information scattered in their files of engineering magazines and catalogs, effectively buried and requiring extensive digging to bring it to light. Mr. Harwood has incorporated much of this basic data in his book and tells where to find additional material. His exposition of the subject of acceleration based on current input peaks and valleys is especially enlightening.

The problems in the book are eminently practical, and have patiently been drawn from wide personal experience. The material is up to date including as it does the AISE 1952 Standards for Brakes as an example. The book is worth having, both as a text book and for reference, for the student and for the engineer responsible for the design, selection and application of motor controls. Reviewed by John L. Skeehan.

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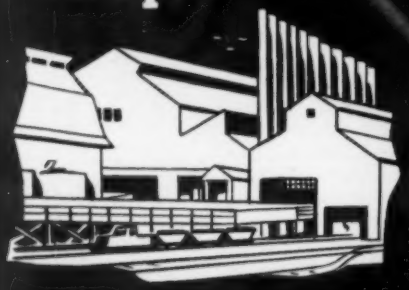
in the majority of open hearth shops



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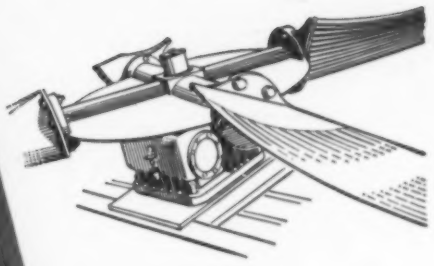

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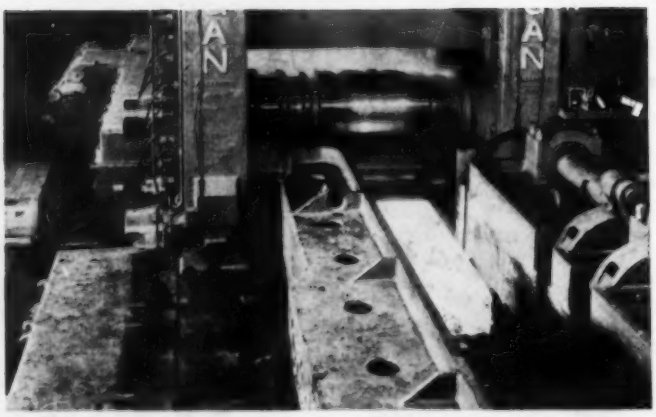

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